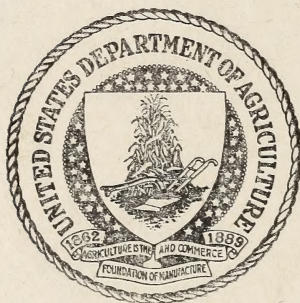


Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES
DEPARTMENT OF AGRICULTURE
LIBRARY



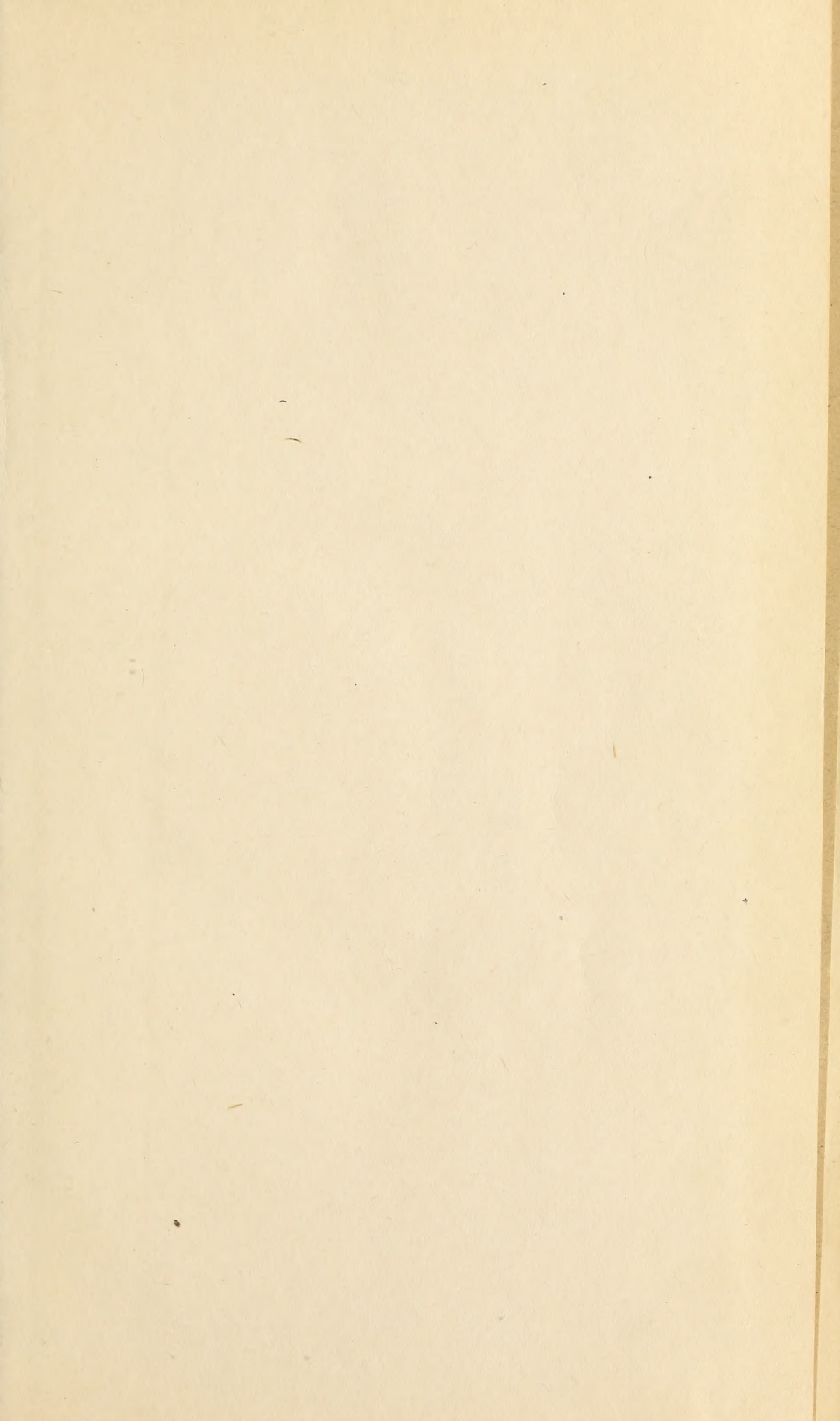
BOOK NUMBER

1

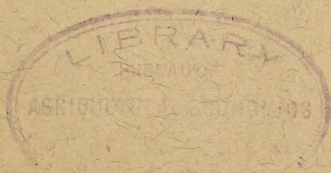
347638

Ag84

1930/31



REPORT *of* THE
SECRETARY OF
AGRICULTURE
1931



347638

REPORT *of* THE SECRETARY OF AGRICULTURE

1931

1
Ag 84
DEC 10 1931



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1931

CONTENTS

	Page
World influences upon American agriculture.....	1
Home market and farm incomes.....	10
Crop adjustments made by farmers.....	13
Crops of the year.....	19
Wheat situation.....	23
Cotton situation.....	25
Livestock situation.....	27
Dairy situation.....	31
Poultry situation.....	32
Fruit and vegetable situation.....	33
Exports and imports.....	34
Significant population changes.....	36
Putting land to the right uses.....	37
Farm-land values.....	40
Taxes.....	42
Agricultural credit.....	43
Drought relief.....	46
Unemployment relief.....	49
Public roads.....	52
New contacts with fruit and vegetable industries.....	55
Agricultural engineering.....	56
Animal industry investigations.....	56
Dairy research and service.....	60
Plant industry developments.....	63
Insect-pest conditions.....	66
Plant quarantines.....	71
Chemistry and soil research.....	73
Forestry.....	77
Wild life.....	82
Home economics.....	85
Food and drug administration.....	87
Trading in grain futures.....	90
Extension service.....	92
Informational work.....	94
Weather Bureau.....	96
Agricultural experiment stations.....	97
Financial statement.....	98

REPORT OF THE SECRETARY OF AGRICULTURE

WASHINGTON, D. C., *November 14, 1931.*

To the PRESIDENT:

WORLD INFLUENCES UPON AMERICAN AGRICULTURE

American agriculture is not a separate, but an integral part of the world's economic system, and it is always deeply affected by financial, industrial, and social conditions at home and abroad. It is more affected by foreign conditions than is American industry, because it depends more heavily on the foreign market. When any country, from year to year, has an exportable surplus of a commodity or group of commodities, the prices realized for the export surplus determine the prices obtainable for the whole supply. In the last decade the United States has exported about 13.2 per cent of its agricultural production, and this trade has constituted approximately a third of our total exports. This third, it should be noted, represents only primary agricultural products in their raw or first processed form, such as wheat and wheat flour, and cotton. It takes no account of many agricultural products that are elaborately manufactured and exported as manufactured goods. Cotton manufactures, leather manufactures, numerous chemical products, and many other commodities are excluded. Forest products are excluded also.

Certain branches of agriculture, notably wheat growing and cotton growing, rest far more heavily on the foreign market than do our manufacturing industries. In short, our export trade in farm products brings a large part of the agricultural industry under foreign-market influence. The proportion of agricultural production which is exported is nearly twice as large as the proportion of industrial production exported. Agricultural prosperity in the United States, therefore, depends enormously on the purchasing power of the foreign market. When there is unemployment, a falling price level, and financial disorder in the countries that take our agricultural surpluses, American agriculture feels the shock of a major depression. Its domestic as well as its foreign market is impaired because reduced foreign buying power means reduced industrial exports and therefore reduced domestic buying power.

These conditions are vital as long as we maintain our present level of agricultural production.

Our agriculture is burdened with surpluses. This has been repeatedly, and, in fact, almost continuously the case since the war. The burden is specially heavy now, not primarily because of great increases over normal production, but as a result of great changes in the demand for our products. The present season, as compared with other post-war years, is one of average total production. Had demand conditions remained as they were in 1929, the output in many lines presumably would have been absorbed without disastrous price recessions. Demand has declined to such an extent, however, that many branches of

our agricultural industry lack a profitable outlet. Lines that were materially overexpanded before the crisis are in desperate straits now. When supply already exceeds requirements, a sharply falling demand makes it intolerably burdensome.]

Why has agriculture's surplus problem become thus aggravated? And from what source or sources may relief be expected? Correct formulation of agriculture's basic problems is essential, for mistaken diagnoses lead to mistaken policies, public and private. Concretely the issue is whether agriculture faces a temporary or a permanent change in its general market situation. In either case, changes in its production will be necessary. But the kind and degree of these necessary changes should be determined by market trends. Explicitly our farmers will have to decide whether it will pay to produce as heavily for export as they have recently. This is the critical point because, as already noted, the foreign market exercises a decisive influence upon the profits of several major branches of American agriculture.

Relationship to European Market Changing

Our dependence on the foreign market arises, of course, from the fact that American agriculture was evolved largely as a source of supply for an expanding industry in other countries, particularly in Europe. In the last two decades this relationship has changed vitally. Changes no less important impend. American agriculture must adjust itself thereto, if it is to be prosperous. Many factors are involved. The most important, as already indicated, is the influence of the foreign market on prices both at home and abroad. Scarcely less important are long-time trends in foreign-market requirements, foreign purchasing power, and foreign competition. International relationships in industry and trade, as well as in agriculture, enter the situation. In former years mutually profitable exchanges between Europe and the United States were possible because this country needed Europe's industrial products and could take them in exchange for grain, meat, and fibers. But our own industry has grown beyond the needs of our domestic market. To-day we wish to export rather than to import industrial products. Furthermore, Europe now has other sources to which it can turn for agricultural goods. It is poor business to shirk facing such facts. Farmers should understand them because exceptional circumstances, most of them an outgrowth of the war, have stimulated our export trade in agricultural products far beyond the level to which it would have tended had the war not thrown events out of their natural course.

Main trends in our changing relationship to the foreign market can be described briefly. In the nineteenth century the relationship of American agriculture to its foreign market was favorable. From 1870 to 1898 our agricultural exports, particularly in cereals, livestock products, cotton, and tobacco, mounted tremendously. These commodities went chiefly to the thriving industrial nations of Europe, whose growing populations became dependent on outside sources of supply. Excluding forest products, our agricultural exports rose from about \$297,000,000 in 1870 to more than \$840,000,000 in 1900. Expressed in an index of volume using the period 1910-1914 as 100, the export index number for 1870 was 25. For 1900 it was 122. The highest point was reached at 136 in 1898. Then a decline began

that continued until the World War. We were approaching a balance between the domestic supply of, and the domestic demand for, agricultural products.

It is significant that the most prosperous period of American agriculture was not the era of rising exports, which in fact included years of ruinously low prices. Rather, the period (1898-1914) of declining exports was the prosperous time. Though we can not say that the decline in exports was the cause of the rise in prices, it obviously proved compatible with the advance. Agricultural prices rose more than the prices of other goods, and the rise was reflected in a rapid and steady increase in agricultural wealth. The average valuation of farm real estate in the United States doubled from 1900 to 1910, and the gain continued at an increasing rate until the war.

Why Farm Exports Dropped Before the War

Our agricultural exports declined before the war for two principal reasons. In the first place, they declined because the United States market increased. Growing consumption at home more than compensated for the decline. Our population increased from 73,000,000 in 1898 to 98,000,000 in 1914, and became more concentrated in cities. The standard of living advanced. Our national wealth, according to the census, increased from \$88,500,000,000 in 1900 to \$186,300,000,000 in 1912. In the same period wealth per capita of the population rose from \$1,165 to \$1,950. This was a period of rising prices, hence the gain in real wealth was somewhat less than the indicated gain in money values. It was substantial, nevertheless, and brought about a more rapid increase in our consumption than in our production of the principal agricultural commodities, though this production increased rapidly. Accordingly agriculture had favorable supply and demand relationships despite its loss of ground in the foreign market.

In the second place, our customers abroad turned increasingly to other sources of supply; to Canada, Argentina, and Russia for grain; to Argentina for meat; to Australia and New Zealand for sheep and dairy products. Foreign countries, with cheaper land and most of them with cheaper labor, were competing with us in the importing markets. Countries in the pioneer stage of agricultural development had advantages comparable to those enjoyed by the United States in its earlier history. In consequence, our farm-commodity exports, including cotton, dropped about 36 per cent from 1898 to the period 1910-1913.

Trend Reversed in War Period

This whole situation, which seemed to promise stable prosperity for agriculture, was profoundly altered by the war. Our agriculture was expanded to meet war-time needs, and the trend toward a lessening dependence upon the European market was speedily reversed. When the war eliminated Russia from international trade in agricultural products and reduced the production of most European countries it gave an immense impulse to production elsewhere. In the United States, Canada, Argentina, and Australia the cereal acreage in 1921 was nearly 20 per cent greater than before the war. Canada's wheat acreage more than doubled. Pork production in the United States, beef production in Argentina, and dairy production in Argentina and New Zealand were tremendously stimulated. By 1918

our own farm-commodity exports, including cotton, reached a point 45 per cent above the pre-war level. More American beef, pork, and cereals were exported to Europe than were sent there at the height of our agricultural export trade in the nineties. From the standpoint of our permanent agricultural interests, this was a hazardous development, which left us with enormous surplus-production capacity.

Surplus production persisted long after the need that called it into existence had passed. Though our agricultural exports decreased in volume after the war from 145 per cent of the pre-war level, the high point reached in 1918-19, to 104 per cent of the pre-war level in 1923-24, they advanced to 136 per cent of that level in 1926-27. In the crop year 1929-30 the volume of our agricultural exports was 97 per cent of the prewar level. Many products, however, were still exported in volumes much exceeding the pre-war averages. Our net exports of grain and grain products in 1929-30 had declined greatly but were still 130 per cent of the pre-war level. Exports of cattle and meat products remained above the pre-war level.

Effective European Demand Overshot

Even had Europe regained its pre-war purchasing power it would not have been a profitable market for all the surplus farm production we had to offer. For one reason, other countries were offering large surpluses there, too. In 1921 exports of pork from all the principal surplus producing countries were 80 per cent greater than before the war. Total exports of beef from the surplus countries were 63 per cent greater than before the war, of butter 104 per cent greater, and of cheese 30 per cent greater. At the same time, Europe was restoring its domestic agriculture. Recovery came first in Denmark and the Netherlands, which were disturbed by but not directly involved in the war. Next, the former warring nations of Europe increased their output. By 1927 the cultivated area of Europe, outside Russia, was back to 97 per cent of the pre-war average. Europe's production of milk, butter, cheese, and pork was above the pre-war level. By 1930 Russia had resumed the exportation of cereals and other agricultural products. In such circumstances even a prosperous Europe would probably have desired less of our farm production than it took before the war. In the hard conditions of the postwar period, it desired much less. True, it took large quantities; but it did so at bargain prices, which returned little or no profit to our producers.

The war, in short, left American agriculture excessively dependent on the European market. Europe's capacity to take American agricultural goods depends essentially on three factors: Its purchasing power, the volume of its own farm production, and the quantity of farm production available to it from other sources. When we compare Europe's present condition with its pre-war prosperity, and consider also the increased competition our farmers meet there, it is obvious that our agricultural exports are still too large. In the contraction of our farm exports from 1900 to 1914, American farmers, as already noted, suffered no harm. They suffered acutely from the decline after the war. This contrast is easily explained. In the pre-war period our farm production, though it steadily increased, did not increase more than the total market, domestic and foreign. In the postwar period, on the other hand, the production increased much

more rapidly than the market, and corresponding increases took place in other agricultural countries. As a result of technical progress, farm output per man engaged in farming in the United States jumped about 15 per cent between 1919 and 1924, and it has increased since. Meantime acreage has increased. Yet not only the foreign market, but the domestic market has weakened, partly because the population is increasing less rapidly than formerly. In the present downward trend of our agricultural export trade, the home market has relatively more slack to take up than it had before the war, and less capacity to do it. Hence the favorable supply and demand relationships that existed then can not be restored without sweeping adjustments in production.

Export Decline Retarded by Credits

This country's agricultural exports to Europe after the war would have fallen more had not the trade been supported by a liberal credit policy. It depended extensively on American capital loans. Nearly half the \$10,500,000,000 loaned by the United States Government to foreign governments was loaned after the war. Loans by private investors after the war came to nearly the same sum. All told, American capital loans to foreign countries, mostly European countries, between 1914 and 1930 aggregated approximately \$23,500,000,000. These advances financed an export movement of industrial as well as of agricultural goods, but in the trade with Europe the agricultural goods predominated. Even with its purchasing power thus augmented, Europe was obliged to curtail agricultural imports. It raised tariffs and adopted milling restrictions to limit dependence on grain imports. It substituted vegetable for animal fats and oils. When in 1929 the stream of American credit to Europe dwindled, Europe was forced to cut its agricultural imports still more. Europe's credit difficulties have reacted vitally upon our agricultural export trade, which can not continue as if nothing had changed.

Monetary Factors in the Depression

Still another aspect of the international credit situation reacts adversely on our agricultural export trade. Before the war the United States was a debtor country, and foreigners owned much of the capital invested in our factories and farms. Our chief creditor was the United Kingdom; other countries, however, had substantial investments in the United States. It was necessary for us to pay interest on the borrowed capital and to liquidate some of the principal. This was accomplished chiefly by the exportation of goods. Our debtor status, in its later stages, produced a heavy balance of United States exports over imports. This did not embarrass the creditor countries because in effect they had paid in advance for much of what we had to send abroad. It is different now. In the war period we paid off our debts and became a creditor country. As a consequence our balance of exports over imports, though it continued, became utterly changed in character. Instead of being a net addition to the current income of the principal importing countries, it was a charge against their future income. It put them in a fiscal position similar to the one from which the United States had emerged. It obliged them to work toward exporting more than they imported. Since they found it difficult to increase their exports, they had to cut down their im-

ports. This necessity will continue as far ahead as we can see. It can not, for obvious reasons, be met as easily as the United States met a similar necessity when this country occupied a debtor rôle. For one thing, the United States does not need what Europe produces as urgently as Europe formerly needed what this country produced. In other words, the Old and the New World are now less favorably placed to exchange goods and services. Each hemisphere is well developed industrially, and deficits are substantial only in Europe's agricultural wants. True, these deficits must be met. But whether they will be met in ways advantageous to the farmers of the United States is a question. Since we do not require Europe's industrial surpluses, Europe may be forced, in large measure, to do without our agricultural surpluses.

Another factor in our agricultural problem lies in Europe's monetary disorders. When Great Britain and other countries resumed gold payments in 1925 and 1926 they released forces that redistributed the world's gold supply. Surpluses accumulated in creditor countries while debtor countries ran short. When gold-standard countries have insufficient gold, they contract their currencies and credit. This causes prices to fall. American agriculture would have been hurt even had it avoided expansion in production. But this should not blind us to the additional handicaps that result from unrestricted production. It is difficult to measure the relative influence of the monetary and the nonmonetary factors in the present crisis. Both, however, are important. Agriculture's attention is properly centered upon the latter because they are measurably within its control. Unless production is adjusted, low agricultural prices will continue after Europe's money troubles are remedied.

The part played by general deflation in the agricultural depression has caused some persons to declare that underconsumption rather than overproduction is the main trouble. This is a distinction merely of words. The surplus is the important thing. Whether created by overproduction or enhanced by underconsumption, the supply controls.

Two Fundamental Requirements

The situation has two fundamental requirements. First, the credit and purchasing power of Europe must be restored. This is essential not only for European welfare but for our own, because we shall need the foreign market indefinitely for some of our products. Second, American agriculture must adjust itself to a declining export trade. As things stand, this need will persist, no matter how favorably matters develop in Europe, because our production is overexpanded in relation to Europe's wants. Should Europe's economic recovery be slow, the necessity for diminishing our farm exports will be the more pressing.

This is not a policy of defeatism, a passive acceptance of declining business. It is a policy of constructive adjustment to a radically changing market situation. What counts in agriculture is not primarily the volume, but the profitableness of farm production. It is better to contract the agricultural industry profitably than to overproduce unprofitably. Here is the challenge of the present situation. In a market that does not keep pace with the increase in production capacity farmers must adjust their production. If they do this by with-

drawing the less productive acres and livestock, they reduce their surpluses and often also their costs of production. Thus they reap a double advantage. They get higher prices and also benefit from wider margins between prices and costs. This favorable margin can be increased by individual efficiency. I discussed the necessity of crop adjustments in my report last year (pp. 24-30) and need not repeat here what I then said. It is a gross error to suppose that efficiency in agriculture leads inevitably to overproduction. It tends on the contrary to promote a good adjustment between supply and demand, because it discourages wasteful competition. It is time to revise the crude notion that only a continually expanding agriculture can be a profitable agriculture. Expansion is justified only when the market is expanding too. When the market is declining or is not expanding at its former rate agricultural profits wait upon adjustment to the change. Effecting this adjustment does not mean abandoning the market to our competitors. It means producing for a real as distinguished from an illusory market, and supports the advantages this country possesses in natural resources, capital, and managerial ability.

This recommendation to reduce the volume of our agricultural exports does not challenge the ability of our farmers to meet foreign competition. They can produce, with or without tariffs, as cheaply as farmers anywhere. But to do so they would have to accept lower living standards.

Surplus Difficulties Largely Export Difficulties

Overproduction is not necessarily and invariably production for export as distinguished from production for the domestic market. It is possible to have an oversupply of goods that are essentially on a domestic basis, such as dairy products and wool, as well as of goods produced largely for export. Taking our agriculture as a whole, however, it is surely true that surplus difficulties are now largely export difficulties. The farm commodities that we sell heavily in foreign markets are those that are depressed most seriously. Wheat and cotton are conspicuous examples.

In urging an agricultural policy directed toward lessening our dependence upon foreign markets we do not ignore the relationships in which different leading products stand toward the export demand. With some products, such as cotton, we have natural advantages that give us competitive strength in international trade. With other products, such as wheat, our position is less advantageous. No uniform prescription can be given as to the place that different commodities should occupy in the export trade. But if a declining agricultural export trade was compatible with American agricultural prosperity before the war, when foreign competition was relatively weak, and when foreign purchasing power was rising, it is much more in order now.

Rapid Shift to Domestic Basis Impracticable

The surplus-production capacity that American agriculture now has can not be quickly eliminated, and a sudden shift from an export to a domestic basis is not practicable. Some branches of our agriculture, moreover, can compete successfully in foreign markets, even against the pressure of world-wide overproduction. Exclusive of that grown

in China, this country, for example, produces about 60 per cent of the world's cotton crop; the economy of specialization in cotton as a cash crop supplemented by home-grown food and field crops, gives many of our growers an advantage even in bad years. The tobacco situation is similar. Excluding Russia and China, the United States produces about 40 per cent of the world's tobacco crop and holds a dominant position in the international trade. It does not follow, however, that unrestricted production of these crops for the export market is warranted. Cotton and tobacco prices, as well as the prices of cereals and meat products, reflect foreign-market influences significantly. There is no profit in persistent overproduction for a declining foreign demand. Our producers may be able to stand the loss as well as any of their foreign competitors, but it is poor business to do so unnecessarily. They should grow the quantity of each crop that can be absorbed, with profit to themselves, either in the domestic market or the foreign market, or in both. When wheat sold at \$1 or more a bushel in western markets, thousands of producers could grow it profitably for export who can not do so at present prices. Their production in recent years has evidently been adjusted to the prices previously received. It could have been more desirably adjusted to price prospects.

With human wants still unsatisfied, overproduction seems an anomaly. Farmers, however, cannot produce for a market that can not buy. They must realize a profit. Agriculture throughout the world has persisted since the war in increasing its production beyond the purchasing power of the available market. This is competition run amuck. It brings no benefit in the long run even to the purchaser, because the distress inflicted upon agriculture hurts other industries, limits their markets and their profits, and forces them to lay off workers. Trade depression such as the world has gone through in the last two years emphasizes, though it does not create, the disparity between agriculture's production capacity and its market. It stresses the folly of production without reasonable prospect of a profitable sale. Agriculture can not shut down as manufacturing industries sometimes do when demand falls off; but this does not mean that agricultural production should continue to disregard market developments. Reducing farm production may often be difficult and sometimes costly, but its difficulty and its cost will certainly be less than that of continuing production on a scale in excess of demand.

Home Market's Importance Not Minimized

This is not an attempt to minimize the importance of the domestic market. We merely emphasize the influence of foreign conditions upon some of our principal crops. If a surplus must be sold abroad, the price falls in the domestic market to a point at which foreigners will buy. This explains why foreign takings have a greater influence on prices than their proportion to the total supply would indicate. No device can be a remedy which tends to increase exportable surpluses. Actually to reduce these surpluses is the only logical course. They can not be forced into unwilling markets.

There is a reverse side to the picture. American agriculture is not wholly on an export basis. Many of its products find a sufficient market within our borders. But this fact, though it may mitigate, does not destroy the influence of the export surpluses. Commodities

that can not be profitably exported may sometimes be substituted at home for products not ordinarily exported, as when wheat replaces corn as feed for livestock. In this way the market for commodities usually on a domestic basis is weakened. Furthermore, slow export trade may prompt farmers to shift their crops so that overproduction may result in crops ordinarily produced exclusively for home consumption. Thus export surpluses tend to weaken the whole structure of agricultural prices. In such conditions an expanding home market lacks the beneficial influence it would otherwise have. No one can tell what the ultimate position of American agriculture in world trade will be. Developments not now foreseen may change matters radically. New foreign markets may be developed, and old ones may be recaptured through technical progress. Present conditions, however, certainly indicate that smaller production for export would mean a more profitable American agriculture.

The Influence of the Tariff

As we produce less for export, the tariff on agricultural products will become more effective. Agriculture will benefit in two principal ways. It will share in the results of a better adjustment of world production to world demand, and will have a stronger, more sheltered domestic market. Tariff protection is of course indispensable to this latter result. Prices can not be higher at home than abroad unless tariffs stand between the domestic and the foreign market. Tariff protection for agriculture is part of our national policy. There is no reason to fear that it will be discontinued. It is already effective for many crops formerly governed entirely by the world market, and covers a progressively larger proportion of our agricultural output. The advantage is not confined to crops definitely and permanently on a domestic basis. It extends to crops still produced substantially for export, because it lessens the incentive to produce these crops in excessive quantities. Farmers have an increasing number of sheltered crops to which they may turn.

The tariff act of 1930 accorded well with agriculture's needs, both present and future. It increased the rates of duty on agricultural products about 30 per cent. This change, besides strengthening the home market for many products already on a domestic basis, enabled farmers to put additional products in a similar position. The new rates helped agriculture materially. Practically all our agricultural imports, both dutiable and free, declined under the influence of the depression. But the dutiable imports declined much more than the free imports. In the 12 months following the passage of the act our imports of dutiable agricultural products fell off by 33 per cent, whereas our imports of duty-free agricultural products declined only 7 per cent. This difference was clearly, in large part, a result of the new tariff. The world's difficulties would not otherwise have caused so unequal a decline. Had the new tariff law not been in effect, world competition would have been felt by our farmers disastrously in the domestic as well as in the foreign market.

No fiscal policy can guarantee agricultural profits in a time of depression. A tariff is justified if it diminishes losses. By this test the tariff act of 1930 is already a demonstrated benefit. Its benefits should be substantial when economic conditions once more become normal. The

tendency, then, as has already been indicated, will be toward increased dependence on the home market. As export surpluses diminish, American standards will become effective on a steadily lengthening list of farm commodities. Agriculture and manufacturing industry in the United States are exchanging rôles in relation to the world market. The former is becoming less and the latter more dependent on export trade. Only the tariff can make this change beneficial to agriculture. On a long view its potential advantages far outweigh its present advantages, substantial though these are.

HOME MARKET AND FARM INCOMES

When surpluses can not be sold abroad they pile up at home. Economic depression abroad can throw many branches of our agricultural industry into distress; when such depression is associated with like conditions in the United States, all agriculture is affected.

In the last year the domestic demand for farm products has declined to an extent rarely before equaled in so short a time. This is mainly traceable to changes in the level of industrial activity, which changes are the most important single cause of fluctuations in the home market for the agricultural goods. In the 1929-30 season industrial production in the United States fell about 20 per cent below the level reached in the preceding year. A further decline of nearly 20 per cent took place in the 1930-31 season.

Money incomes of factory workers declined more than the volume of industrial production. This reduction, besides involving an enormous cut in the purchasing power of wage earners, reflected a decline in the buying power of other urban groups, since it betokened reduced industrial profits. Wholesale and retail trade and the professions were damaged proportionately, with bad effects upon the farmers' markets. Some groups with more or less fixed money incomes found their purchasing power increased through falling prices, but the trade slump caused a heavy net drop in the purchasing power of the Nation as a whole.

Agricultural Prices Decline Most

Trade depression invariably causes agricultural prices to fall sooner and lower than the prices of other goods. This tendency, which was painfully in evidence in the depression of 1921, received a new demonstration in 1930 and 1931. In a general price decline such as that which has affected practically all commodities in the last two years, agriculture would be injured even had its prices not fallen more than those of other economic enterprises. Falling prices always mean falling profits, since costs of production never decline proportionately at once and usually not for a long time. The injury to agriculture is greatly increased by the excessive degree to which farm commodities have been affected. Special interest attaches to this aspect of the problem because it suggests part of the remedy. When agricultural prices fall more than other prices, the fact shows, among other things, that agriculture is having more difficulty than other industries in readjusting its production.

Causes of the Disparity

Such disparities tend to disappear as business revives. Farm prices which fall faster in depressions rise faster in recoveries. The disparities arise in periods of depression from the fact that farm production is not easily or quickly adjusted to market changes, whereas the output of many nonagricultural commodities is adjusted promptly. In agriculture, production continues to overshoot demand; in industry, on the other hand, the maladjustment between supply and demand shows itself in unemployment rather than in a persistent accumulation of commodities. Hence, agriculture is penalized unavoidably. Its readjustment difficulties are intensified by the fact that other economic enterprises solve such difficulties by methods that weaken the farmer's market. Another factor in widening the spread between agricultural and nonagricultural prices is the difference in competitive conditions in agricultural and in industry. The prices of practically all agricultural products reflect changes in demand conditions quickly. On the other hand, the prices of many nonagricultural products are more or less customary, and depend largely on elements other than those springing from the immediate business situation. Then, too, agriculture is handicapped by relatively great difficulty in reducing its overhead costs. All these circumstances are finally expressed in a lagging agricultural adjustment to the diminishing market. Crop shifts take place, but agricultural production as a whole tends to be maintained. Our total acreage this year is about the same as it was last year; on this acreage we are producing surpluses that demoralize the markets and return no profits to farmers.

Price changes, absolute and relative, are not the only factor in determining farm incomes. It is necessary to consider also the volume and the cost of production. Fairly comprehensive statistics are available as to the volume, but not as to the cost of production, which varies greatly on different farms and in different regions.

Gross Returns From Farming

Some measure of the decline that farm earnings have suffered in the last two years is afforded, however, by data available as to the gross return from agricultural production. Gross income from the agricultural production of the United States for 1929 was about \$11,911,000,000, and in 1930 about \$9,347,000,000. It is not yet possible to state the gross income from the farm production of the current season. On the basis of figures heretofore available it may be less than \$7,000,000,000. The recent upturn in prices will of course affect the estimate.

At this writing (November, 1931) some of the principal crops are not yet completely made, and the marketing season has several months to run. Certain broad conclusions are indicated. Thus, in the first eight months in the calendar year livestock and livestock products were marketed in about the same volume as in the corresponding period of 1930, but the prices were very much lower. On October 15, 1931, the prices received by farmers for this group of commodities averaged 36 per cent below those of the corresponding date in the previous year. The prices of dairy and poultry products were 21 per cent lower.

In 1930, the last year for which complete data are available, gross income from grains was only \$760,000,000, as compared with \$1,281,000,000 in the previous year. Gross income from cotton dropped to \$748,000,000, as compared with \$1,389,000,000 in 1929. Income from meat animals was about \$2,455,000,000, as against \$2,817,000,000 in 1929. All livestock and livestock products brought a gross income of \$5,296,000,000, or about 15 per cent less than in the previous year. The corresponding reduction in the income from field crops was about 48 per cent. Net income from agricultural production in 1930 declined proportionately more than the money incomes of factory employees and considerably more than the incomes of certain other groups.

Net returns to producers, which are what is left after deducting the expenses of production, unquestionably declined proportionately more than the gross returns. In field crops, prices declined proportionately much more than the production increased. Grain production is only moderately greater than it was last year, yet grain prices on October 15, 1931, averaged about 50 per cent below those of October 15, 1930. Cotton production is about 22 per cent greater than in 1930, yet cotton prices on October 15 were 45 per cent lower than on the corresponding date of the previous year. The production of fruits and vegetables increased somewhat; the prices of these commodities averaged about 45 per cent lower. At the prevailing price levels, the year's increased volume of production not only failed to prevent the gross farm income from declining below that of the previous year, but did not prevent it from falling below that of the depression year 1921.

Effect on Net Incomes

Some small compensation for price declines has come to the farmers during the last few years in the shape of reduced production costs. In 1930, and to a still greater extent this year, necessary expenditures for labor, fertilizer, farm equipment, machine supplies and repairs, and feed and seed declined. Farm wages and prices of the goods used in farm production were about 15 per cent lower this fall than last fall. As already indicated, however, the expenses of farm production tend to decline less rapidly than the prices of farm products. Against a 15 per cent drop in certain leading farm expenditures, it is necessary to set a possible 25 per cent drop in gross farm income in 1931. Furthermore, not all the reductions that take place in farm expenses go on the credit side of the agricultural ledger. Feed and seed, for example, are bought by some farmers and sold by others. Thus gain to one group is offset by loss to another. Savings on labor, machinery, oil, gas, tires, etc., are, of course, actual net savings to agriculture. They do not suffice, however, to offset the tendency of other farm expenses to remain fixed in time of depression. Taxes do not fall with farm-commodity prices nor do interest charges and principal on mortgage debt. When the purchasing power of farm commodities falls as much as it has since 1929, the proportion of the farm output that must be surrendered in payment of taxes and principal and interest on loans increases. Perhaps the heaviest burden that depression puts on agriculture is the difficulty it creates in meeting fixed charges.

Reductions in the expenses of production have not nearly sufficed to counterbalance the drop in gross incomes. Hence the net income of the farmers from the production of 1930 declined proportionately more than the gross income. It fell short of providing a wage allowance for

the farm operator's labor at going farm-labor rates, and left no net income whatever available for the farmer's capital or management.

Adjustment to Main Trends Imperative

Agriculture, if it is to be continuously profitable, must be adjusted to long-time trends. This fundamental requirement is far more important than the need to vary farm output with temporary market changes. It is desirable, of course, to match temporary market shifts with corresponding adjustments in output. It is imperative to make adjustments to long-time changes. When main trends turn against agriculture, the penalty for failing to adjust output is disaster. It does not follow, simply because a certain volume has been absorbed not unprofitably for a number of years, that a sound balance has been struck. Possibly the production has been continued for a market essentially precarious. This is potential overproduction which may turn suddenly into actual overproduction. Even when business becomes active again, a brake will have to be kept on some branches of American agriculture.

CROP ADJUSTMENTS MADE BY FARMERS

Extensive crop shifts have been made by the farmers of the United States in recent years. Unfortunately these shifts have not gone far as yet toward adjusting production to consumer demand. Contraction in some regions has been offset by expansion in others, particularly in wheat and cotton. On the whole, expansion has exceeded contraction. This is so plainly against the interests of the farmers that careful study of the question is necessary to indicate how crop adjustments may be better engineered. The best way to see what is required is to note the results of what has already been attempted.

Net farm incomes have been so low since the war that the farmers might have been expected to reduce their acreage. Instead they increased it. In 1930 the United States had 366,500,000 acres in crops, the highest total on record. This was an increase of 55,000,000 acres since 1909. Lessening demand for farm products, at home and abroad, and repeated warnings against overexpansion did not prevent the 1930 crop area from increasing 2,000,000 acres over that of 1929. The increase over the 1909 figure is specially remarkable since the last 12 years saw a decline of about 8,500,000 head of horses and mules on farms and a consequent release of approximately 20,000,000 acres (not including pasture) formerly required to produce feed for work stock. Land thus released, which previously produced raw material for animal power, now produces foodstuffs for the market. Wheat acreage, which rose from 44,262,000 acres in 1909 to nearly 75,694,000 in 1919, dropped after the war to 52,535,000 acres in 1924, but rose again to 61,464,000 acres in 1929. The acreage for harvest this year, despite the low prices that prevailed for wheat during 1930, was reduced only about 6 per cent below the 1929 level.

Regional Changes Conflict

Regional aspects of the wheat-acreage problem show the difficulty of getting concerted action when reduction is desirable. In the region east of the Mississippi wheat acreage dropped from about 18,000,000

acres at the close of the war to about 11,000,000 acres in 1930, or to a point below the pre-war level. West of the Mississippi, however, tremendous expansion occurred, particularly in the southwest winter-wheat States. Kansas's wheat acreage this year is estimated at 12,572,000 acres, as against 4,810,000 in 1911. Montana last year harvested 4,000,000 acres of wheat, as compared with less than 1,000,000 acres in 1914. The aggregate wheat acreage of Colorado, Nebraska, Texas, and Oklahoma in 1930 was 11,400,000 acres, as compared with about 7,800,000 acres in 1914. Reductions in the East, where farmers can turn to other crops, were more than offset by increases in the West where crop shifts are difficult.

Equally striking is the way in which cotton acreage reductions in one region were offset by expansion in another. In the old Cotton Belt, where the boll weevil did heavy damage in 1921, 1922, and 1923, cotton as the principal cash crop was wiped out in some sections, and some cotton land went entirely out of production. In the weevil-infested area generally cotton was widely replaced by feed crops and pasture. In the cotton States east of the Mississippi the acreage in truck crops increased, from 1919 to 1930, about 154 per cent. West of the Mississippi, particularly in Texas and Oklahoma, the cotton area increased greatly. Texas and Oklahoma together had 23,000,000 acres in cotton in 1926, as compared with 12,900,000 acres in 1919. This year the cotton acreage in these two States is about 3,500,000 acres below the 1926 figure. Our total harvested cotton area in 1930 was 45,218,000 acres, as against 33,566,000 acres in 1919.

Corn Acreage Remarkably Uniform

Our corn acreage has been remarkably uniform at about 100,000,000 acres for several years. Though the acreage in corn this year is the largest since the record acreage of 1917, it is only 8.6 per cent above the lowest acreage in the last quarter of a century. Corn acreage is relatively stable because the crop returns a comparatively large gross income per acre under a wide range of climatic conditions. Nevertheless, regional adjustments take place. Corn has moved west and north in the last decade. A reduction of about 5,200,000 acres east of the Mississippi has been offset by an increase of about 7,800,000 acres in Minnesota, North Dakota, Iowa, South Dakota, and Nebraska.

Flax acreage increased from 1,113,000 acres in 1922 to 3,692,000 acres in 1930, to some extent at the expense of wheat and grass. The production of truck crops and vegetables (not including potatoes) has increased at an average rate of about 10 per cent a year since 1921, though in the last few years the outlook for these crops has not been satisfactory. Vegetable and truck-crop production, however, can be increased greatly without drawing much land from other crops.

When major crops are overproduced, the difficulty may be mitigated but can not be overcome for the country as a whole by changing to minor crops. Six major crops have a combined acreage which usually makes up more than 85 per cent of the total crop acreage. These crops are corn, hay, wheat, cotton, oats, and barley. Only about 46,000,000 acres, or less than half the area we devote to corn alone, is used for producing 70 or more minor crops. It is obviously impossible to change largely from the production of these major crops to the production of the minor crops without disturbing the market for the latter. Sizeable

acreage adjustments among the major crops necessitate either changing from one major crop to another, abandoning crop land, or increasing the area in pasture. Shifting acreage in the major crops is practicable only when some of them are in short supply. Abandonment of acreage, though large in recent years, may be offset by expansion elsewhere. Returns from most pasture are relatively so low that a change from crops to pasture is a last resort where land is good. All the courses open are difficult, a fact which largely explains the tendency of farm production to stay above market requirements when demand falls. It is a tendency that must be combated if farm profits are not to vanish altogether in a period of rapidly falling prices. Temporary abandonment of farm land in extreme situations is preferable to farming it at a loss. The individual farmer faces many practical difficulties in adjusting production, as will be pointed out presently. The main problem is one of reconciling individual interest to group interest through concerted action of producers.

Adjustments in Livestock Production

Changes in the production of livestock can not be made as quickly as changes in the production of field crops, though the output of some livestock products can be changed quickly. Shifts in hog production mainly go in cycles, but depend on shifts in field crops, and also on changes in the use made of crops. Dairy expansion in the Eastern States in recent years has gone along with a decline in hog numbers in that area. On the other hand, hog production has increased where corn has replaced wheat and other crops. Hog producers have partly met the challenge of declining prices by increased efficiency both in swine sanitation and in the utilization of feed. In the beef-cattle industry, which has a long production cycle, adjustment to declining prices is extremely difficult. Since 1928 the number of cattle on farms has increased from 55,500,000 to 59,000,000, despite warnings that increased production would mean lower prices. The greatest increase has taken place in the North-Central States, where pasturage, roughage, and grain are most abundant. Production is at last being curtailed in the sheep industry, whose output expanded 43 per cent between 1922 and 1931. The expansion was general in all sheep-producing sections and continued despite numerous warnings that overproduction impended.

Outlook Service

Such facts show that attempts of farmers to shift their production to better paying lines are often confused and conflicting. Better facilities for concerted action are needed. Some progress has been made in developing such facilities. There is growing solidarity among farmers in the cooperative movement and in various other forms of organized effort. There is also rapid growth in the use of economic information as a basis for cooperative adjustments. The Department of Agriculture collects and interprets the data needed. This service deals not only with the supply of and the demand for various products, but also with farm-management problems. Too often farmers adjust their production on the basis of currently received prices or prices received in the preceding year, apparently in the mistaken belief that similar prices will necessarily continue. This practice is a basic cause of cyclical fluctuations in production. Alternate expansion and contraction result in wasteful crop and livestock shifting.

Farmers must take into account a complexity of forces in planning their production program. They can not supply themselves with the necessary information and its interpretation. This fact, and the public importance of adjusting production to demand, make the task of supplying outlook information a public function. The department began systematically to meet this need eight years ago, when it established an outlook service. The service has become a cooperative undertaking between the department and State agencies.

It is planned in national, regional, and State conferences. The resulting information is made available to producers in all parts of the country, through published reports, press material, radio addresses, and direct contacts with farmers. In 1930 six national and regional conferences were held, with nearly 400 State specialists in attendance. Forty-five States issued special outlook reports supplementing the department's data and interpretations with information specially pertinent to particular States and local areas. Nearly 1,300 meetings were held for training local leaders in this work, as compared with 540 such meetings in 1929. Also 9,135 farmers' meetings, with an aggregate attendance of 601,000, were held to disseminate economic information, as compared with 4,240 such meetings with an attendance of 204,000 in 1929.

Economic information is meeting a rapidly growing demand in vocational education. In the last fiscal year approximately 95,000 farmers were enrolled in evening classes, as compared with 65,000 in the preceding year. Those in charge of this work in the Federal Bureau for Vocational Education cooperate with specialists in the Department of Agriculture. Economic material has an important place in the instruction.

Regional differences in soil, topography, and climate, and in other factors of fundamental importance in shaping types of farming and trends of production, are recognized by the department and the State agencies in their research and extension work. In farm-management investigations a beginning has been made in determining differences in types of farming and in organizing research into regional programs.

Compulsory Adjustments Inadvisable

I have repeatedly emphasized the need for curtailing acreage and livestock breeding, and have urged that this be done by voluntary concerted action. This course seems preferable to the compulsory production control lately advocated in the cotton States. The doctrine that production can be better controlled by law than by the judgment and decisions of producers is probably repugnant to our Constitution and certainly repugnant to the character of our economic system. Production adjustments are more necessary now than they were a year ago. Appeals made then for voluntary concerted action met with an inadequate response. It has been inferred that voluntary action must fail unless supported by legal action. This does not necessarily follow. Acreage cuts and reductions in livestock breeding were relatively small last year, probably because farmers were not then convinced of their urgent necessity. The situation has changed so much since that it seems impossible to doubt that they are convinced now. If they are, voluntary action should do what is required. If they are not, legislative action will meet with resistance.

All plans for general cuts in production meet the difficulty that farm production costs vary on different farms and in different localities. Hence prices that mean loss in one place may permit profits elsewhere. Individual farmers can sometimes do business profitably at prices that ruin their neighbors. When prices fall, it is advisable for most farmers to reduce their output. But it never happens that they should all reduce their production to the same degree. Reductions should be adjusted to the necessities of individual farms, so that the higher-cost acres and animals will be withdrawn first. Blanket reductions, applying equally to all farms and all farmers, are not desirable because such reductions press equally on the efficient and on the inefficient farmers, and equally on good and poor land. This goes against the first law of efficiency.

Under the plan of voluntary adjustment, many individuals must agree on a common course before anything can be accomplished. Moreover, the equal participation of all areas and all individuals can not be assured, nor can an equal distribution of the resulting benefits. These are undeniable difficulties. Yet I think they are less serious than the difficulties that would arise from a compulsory control of production. Such a system would fail completely to allow for the different necessities of different farms and different regions. It would certainly be opposed. It would also be inflexible. Lawmaking could not keep pace with market developments at home and abroad. Eventually the control laws would be ignored. In so far as they were observed they would tend, far more than any plan of voluntary adjustments, to throw our crop system out of balance, because quick crop shifts would be largely ruled out. Arbitrary reductions in the acreage of one or two crops would divert excessive effort to other crops. Surplus difficulties would spring up in new places, under conditions tending to perpetuate them. With their initiative fettered, farmers would find remedial action difficult. Moreover, the proposals so far made for the legislative control of acreage are State or regional proposals, whereas our problems of agricultural production are essentially national. Regional action can do nothing not likely to be offset by opposite action in other areas.

Individual Readjustments

Many difficulties confront farmers who wish to promote regional crop readjustments. When an individual farmer has no assurance that the other farmers will join in reducing the acreage of a crop, he must try to establish the combination of crops and livestock that promises the most return on his own farm. When prices are very low, readjustments by shifting from one combination of cash enterprises to another do not produce significant increases in the farm income. Such readjustments, however, are not without importance, though they do not fully meet the emergency. Readjustments on individual farms may bring results (1) by increasing the noncash income of the farm family in food and feed crops and meat and other livestock products for use on the farm, and (2) by curtailing cash outlays. Extension workers emphasize the "live-at-home" type of farming. This is much to the point now. Through these two methods—production of more commodities for direct use on the farm and modification of farm practice to save cash outlay—reduction takes place in

the commercial output of farm products through the actions of the individual farmers. These adjustments are, at best, a painful process, which emphasizes the urgent necessity of avoiding or at least minimizing the price slumps in agriculture by voluntary adjustment through concerted action.

Efficient Methods Reducing Costs

Mechanization continues to reduce costs of production in agriculture. With modern equipment one man can now handle 160 or more acres in the Corn Belt, as compared with an average of about 80 acres only a few years ago. Two-row and four-row cultivators handle nearly two and four times as much corn as the old one-row cultivator handled. Two-row mechanical corn pickers, with two men to run them, do as much work as six hand pickers. Duck-foot cultivators and row weeders almost eliminate the necessity for plowing in the summer fallow wheat areas of the West, and increase materially the summer fallow handled by one man. In the Great Plains a 16-foot combine harvests and threshes 35 to 40 acres of wheat a day. One such harvester can handle 500 acres of grain in 15 days. In 1928 the cost of harvesting an acre in Kansas by the combine was about \$2.20, as compared with \$3.50 for harvesting with a header and thresher, and \$4.40 for harvesting with the binder and thresher. Nearly 66,000 combines were sold in the United States in the period 1927-1930. In Kansas the number of combines increased from 2,796 in 1923 to 16,631 in 1929. Combines are now used in every State in which small grains are of any importance. In the Mississippi Delta, with modern power machinery, only 30 to 35 hours of man labor are required to grow an acre of cotton ready to pick, as compared with 80 hours under the old 1 or 2 mule system. In haying, one man, with a tractor-drawn mower and a side-delivery rake, covers 25 acres a day, or fifty times the area one man could cut and rake a century ago. If the windrow needs turning, it can be done with the tractor and the side-delivery rake. Production costs are reduced also by the use of better seed and more fertilizer, and by the more scientific handling and feeding of livestock. In the Southeastern States yields of both corn and cotton have been greatly increased through the use of winter legumes.

Long Life Probable for Family Farm

In certain areas mechanization has greatly increased the size of farms and the investment per farm. It has been suggested that this development may foreshadow an increase in corporation farming as distinguished from family farming. Mechanization, however, does not necessarily involve corporation farming or absentee ownership. It is quite consistent with the family-sized farm, though it may make that farm larger. Much interest has been manifested since 1920 in large-scale farming, corporation farming, "chain" farming, and the like. A few conspicuous developments have taken place. But the movement toward the consolidation of holdings and toward farm operations on a large scale has not gone far. For the present, the subject is interesting mainly in its potentialities.

Large-scale farming as yet is a very minor thing in American agriculture. The capital value of all corporation farms that made income tax returns in 1924 was only 2.7 per cent of the total capital value of all the farms of the Nation. Some increase has taken place since 1924 in corporation farming, but the developments have not been spectacular. More remarkable is the change that has taken place since the war in the size of the family-farm unit, particularly in the Great Plains and in the newer cotton areas. The same tendency, though less pronounced, is evidenced in parts of the western Corn Belt. By enabling the family labor supply to cover more land, power machinery tends to conserve rather than to destroy the family-farm system. Long life is probable for the family-sized farm because the nature of farming does not admit of the standardization necessary to the economical employment of large labor forces. Farms have increased in size in the United States in recent years without any corresponding increase in the amount of human labor employed per farm, but rather with a tendency in the opposite direction.

CROPS OF THE YEAR

Fall rains ended drought in most of the States that were drought stricken in 1930. But the winter was remarkably dry. Precipitation was less than half the normal over a large central northern area between the Lake region and the Rocky Mountains. Snowfall in the western mountains was so deficient that the supply of irrigation water was much reduced. On many western mountains the stored snowfall at the end of the winter was the smallest in 20 years. Rainfall in the spring months was generally sufficient, except in the Dakotas and Montana and in some districts further west. Only about half the normal rain fell in the Dakotas and Montana during the three spring months. Some parts of the more western States fared little better. This was North Dakota's third and Montana's fourth successive year of subnormal moisture. Minnesota had a deficiency also. In fact, the moisture supply in that State has been somewhat deficient every year since 1919. Good spring rains fell, and favorable temperatures prevailed in the Eastern States from New England to the Gulf of Mexico. The central valleys, though somewhat drier than usual, had enough moisture for satisfactory crop growth. In parts of the South, particularly in the Southeast, the weather was too dry in June, and the moisture supply continued short in the Northwest and Western States. Elsewhere June weather was favorable, and crops made good growth. July brought general relief to many southern localities that had previously been short of moisture, and also favorable rains over a wide belt from the middle Mississippi Valley eastward to the Atlantic Ocean where the 1930 drought was most severe. In this area the contrast between July rainfall in 1931 and July rainfall in 1930 was striking. In some States it was several times greater this year than last. Weather conditions were unusually favorable for maturing and harvesting the winter-wheat crop. In the spring-wheat States, however, heat and continued drought took heavy toll of wheat and severely damaged cultivated crops and pastures. Rainfall was insufficient for pastures over large areas of the interior valleys and in the Northwest, and also in the western grazing sections. Hay production was reduced. In the Southern States, on the other hand, moisture and temperature conditions continued favorable.

Principal Crops

The United States this year produced large crops of cotton, tobacco, and winter wheat, and short crops of hay, spring wheat, and flaxseed. There were no pronounced deficits or surpluses of the other staple crops. Apples and peaches were produced in abundance. Crops with large acreages in the West suffered greatly. Ample winter and early spring rains, followed by a dry growing season, were ideal for winter wheat, cotton, and tobacco. In the area that was drought stricken in 1930, only Montana, Wyoming, and western North Dakota suffered again this year. The Ohio-Mississippi River area had abundant rain.

Acreage

Abandonment of fall and winter sown crops was small, and the spring was favorable for planting and seeding. On July 1 the area available for harvesting totaled 360,784,000 acres, 0.2 per cent less than the harvested acreage of 1930. Hundreds of thousands of acres were subsequently abandoned in the drought areas of the Western States. Abandonment of cotton acreage, however, was much below the average. In consequence, the total acreage of crops harvested was only slightly less than in 1930. Corn planting increased 4.1 per cent; oats, 2.8 per cent; tame hay, 0.9 per cent; potatoes, 10.7 per cent; and sweet-potatoes, 20.6 per cent. Cotton planting decreased 10 per cent; barley, 1 per cent; flax, 15.2 per cent; tobacco, 1 per cent; and wheat, 4.7 per cent. The shift from cotton and wheat to feed crops was logical in view of the prevailing low prices for wheat and cotton and the short production of feed crops in 1930. Expansion in the acreages of vegetable crops for shipment and for canning was checked. Truck crops for table decreased 1 per cent, and those for canning 18 per cent.

Cereal and Other Food Crops

A very large crop of 775,000,000 bushels of winter wheat overshadowed a near-failure crop of only 109,000,000 bushels of spring wheat, so that the total wheat crop (884,000,000 bushels) was 7.5 per cent above the average of 1925-1929. The winter-wheat crop was 42 per cent greater than the average, while the spring-wheat crop was only 40 per cent of the average. Of the spring wheats, the durum-wheat production of 20,000,000 bushels was less than one-third of an average crop. Spring bread wheats were less than 43 per cent of the average production. Rye, while grown principally in the 1930 drought area, was harvested early and produced 36,200,000 bushels, as compared with an average production of 46,100,000 bushels.

Rice production was 41,700,000 bushels—800,000 bushels greater than the 1925-1929 average. The buckwheat crop of 10,600,000 bushels was much above the last year's short crop of 7,900,000 bushels, but 21 per cent below the 5-year average. A crop of 20,000,000 bushels of dry beans was less than last year's large crop but still above the 18,400,000-bushel average. Cowpeas, an important food crop in the Southern States, were in abundant supply. Peanut production was 929,000,000 pounds, as against an average of 796,000,000 pounds. Sorghum for sirup yielded 24,400,000 gallons, nearly double the 1930 production and 85 per cent of the average. Sugarcane acreage was increased, but the yield per acre was low, and the production of 19,100,000 gallons of sirup was 10 per cent less than average. The sugar-beet crop was about average.

Cotton

The cotton crop was estimated on October 1 at 16,284,000 bales. At this figure it is the second largest ever produced. The largest was grown in 1926, when 17,977,000 bales were ginned. There was a production of 16,135,000 bales in 1914. This year's crop is 6.7 per cent above the 1925-1929 average of 15,268,000 bales. Acreage planted to cotton was 10 per cent less than in 1930, but abandonment was light, and the acreage left for harvest was 40,889,000—greater than the acreage harvested in any year prior to 1924, but 9 per cent below the 5-year average. Almost ideal weather conditions in all parts of the South, and below-average weevil infestation, more than offset the reductions in fertilizer applications. The yield per acre was 190.5 pounds, the greatest since the record yield of 209.2 pounds per acre in 1914. Yields per acre were well above average in every cotton-producing State.

The Feed Crops

The combined production of the major feed grain crops—corn, oats, barley, and grain sorghums—was 103,000,000 tons. This was a production 14 per cent greater than in 1930, but 5 per cent below the annual average in the 5-year period 1925-1929.

The corn crop was estimated at 2,703,000,000, bushels, which is practically equal to the 5-year average production. The crop was short from Michigan, Iowa, Nebraska, Kansas, and Oklahoma west to the Pacific, the shortage varying from 3 per cent in Oklahoma to 70 per cent in South Dakota. In the remainder of the country it was generally above the average.

Oat production was 1,174,000,000 bushels, 14 per cent less than in 1930 and 11 per cent below the 5-year average. Dry, hot weather at ripening in July accounted for the reduced yield. Exceptionally low yields were recorded in the Dakotas, Montana, and Wyoming, with low yields in a group of neighboring States from Wisconsin to Nebraska and west. On the other hand, heavy yields were harvested from Missouri and Kansas south to the Gulf.

A large proportion of the country's barley crop is grown in the States that suffered from drought. The yield per acre was only 16.9 bushels, as compared with 5-year average yields of 25.9 bushels. Only 216,000,000 bushels (82 per cent of the 1925-1929 average production) was produced on an acreage 25 per cent above the 5-year average.

Grain-sorghum production in the Southwestern States was estimated at 129,100,000 bushels, half again as large as in 1930 and 3 per cent above the 5-year average.

The hay crop was short. Production was 88,400,000 tons, as compared with 89,600,000 tons in 1930 and a 5-year average production of 107,500,000 tons. The wild-hay crop was cut to two-thirds of the average, and the alfalfa crop was much below the average. There was extensive killing of the new seedings of clover and other grasses in the 1930 drought area. The effect on the 1931 crop was counteracted as to quantity by the use of emergency hay crops. The coarse nature of some of these emergency hays and a heavy admixture of weeds in clover and timothy meadows, lowered the quality of the crop materially.

The supply of feed grains is supplemented by cottonseed and linseed meal and wheat by-products, and in exceptional years, like 1930, by the feeding of wheat. This year production of cottonseed meal will be large. Of linseed meal, however, the production will be small. The supply of bran and middlings should be well up to the average. Products supplemental to the hay crop will be in smaller supply. Corn, grain sorghums, and sorgo (sweet sorghum) forage will be somewhat more plentiful. The carry-over of old hay, which was large a year ago, was very small this year, and grain pastures are neither so plentiful nor so productive as they were last year.

Tobacco and Flax

A new record in tobacco production appears to have been set. The crop was estimated in October at 1,661,000,000 pounds. This is slightly larger than the 1930 crop, the largest previously, and 22 per cent above the average production during the previous five years. The season was favorable, and a slight decrease from the 1930 acreage was more than offset by increased yields. Burley-tobacco production (468,000,000 pounds) was more than 70 per cent above the 5-year average. The production of flue-cured tobacco, at 694,000,000 pounds, was much below the production last year, but slightly above the 5-year average. Fire-cured tobacco, 207,000,000 pounds, was 26 per cent above the average. Final yield and production figures will depend upon shrinkage in curing. The curing season in 1931 was generally favorable.

The flax crop was grown in the 1931 drought area. It totaled only 11,500,000 bushels—barely half a crop. Average production is 20,900,000 bushels. The quantity, including imported seed, used in crushing in the United States has averaged about 39,000,000 bushels in recent years. The yield on planted acreage in North Dakota was only 2.7 bushels, and for the United States only 3.7 bushels.

Fruits and Vegetables

Fruit production was ample. Of the five principal fruits, apples and peaches were each more than one-fourth above the 5-year average; pears were one-tenth above it; orange production was about the average; and only grapes were below the average. The production of these five fruits combined was about 10 per cent greater than the 5-year average and about 17 per cent above the production in 1930. The apple crop was reported at 223,000,000 bushels, with a commercial crop of 37,600,000 barrels. In the two principal apple-producing States, Washington and New York, the crops were about equal to the average of recent years. In the central area from Pennsylvania, Maryland, Virginia, and North Carolina west to Michigan, Illinois, Missouri, and Arkansas, the crop was from 50 to 150 per cent above the average. The production of peaches was about 78,000,000 bushels, a new record. Home canning was stimulated by low prices, but large quantities of peaches were allowed to go to waste for lack of a market.

The pear crop of 24,000,000 bushels was 13 per cent less than the record 1930 crop, though 9 per cent above the 5-year average. Just as in the case of apples, it was the central group of fruit States, rather than New York and the Pacific Coast States, in which production was held above the average.

The grape crop in California was greatly reduced by drought, heat, and insect damage. It was only 1,300,000 tons, as compared with an average production of 2,200,000 tons. New York, Pennsylvania, Ohio, and Michigan—the leading grape States of the East—had crops ranging from 8 to 50 per cent above the average. Total grape production was about three-fourths of the 5-year average.

The crop of prunes in the Pacific Coast States was much below the 1930 crop, but just about equal to the 5-year average consumption of both fresh and dried prunes. The crops of oranges and grapefruit in Florida are estimated at about one-fifth less than the large crop of 1930. California citrus production will probably be about the average. A large crop of cranberries was harvested.

The production of potatoes amounted to 375,000,000 bushels, about 9 per cent greater than in 1930, but about 2 per cent less than the average crop. The yield per acre was 106.9 bushels—3.3 per cent below the 10-year average. The area planted was 3,506,000 acres, or 4 per cent greater than the average acreage from 1925 to 1929.

The crop of commercial early potatoes was about 46,000,000 bushels, greater by 3,000,000 bushels than in 1930 and 7,000,000 bushels above the 5-year average. In 19 surplus late-potato States, the production of 255,000,000 bushels was 9 per cent greater than in 1930; in 16 deficit States, production was 3 per cent more than last year.

The sweetpotato crop was hurt by dry weather in September, but the acreage was much greater than in 1930, and the production was 77,000,000 bushels, or 15,000,000 bushels greater than in 1930 and only 3,000,000 bushels less than the 5-year average. The production of cabbage, onions, and tomatoes for canning was considerably below that of 1930.

WHEAT SITUATION

This has been a disastrous year for wheat growers, but the first seeds of the trouble were planted many years ago. They were wheat seeds and led to world-wide overproduction. When the war deprived Russia of its customary wheat market in western Europe and also curtailed all European wheat production, the wheat industry was enormously stimulated in the United States, Canada, Argentina, and Australia. As already noted our own wheat area decreased after the war but rose again to 61,464,000 acres in 1929, and was only about 6 per cent below that figure this year. In Canada, Argentina, and Australia, after a spurt during the war period and a temporary decline afterwards, wheat acreage climbed similarly. The aggregate increase for these three countries between 1924 and 1929 was no less than 10,000,000 acres. Russia began expanding its wheat acreage in 1923 and reentered the world's wheat market in 1930 with a wheat production equal to or greater than its pre-war production. The wheat area in Russia harvested in 1931 was officially reported to be 92,400,000 acres, an increase of 8,600,000 acres over the 1930 wheat acreage. Including the estimated production of Russia but not that of China, the world's wheat output in 1930 was nearly 4,900,000,000 bushels, as compared with a pre-war record of about 4,100,000,000 bushels in 1913.

Seldom has a more extreme example of overproduction existed in modern agriculture. It is a cumulative, and not merely a seasonal, condition. This is shown by the mounting world carry-overs, which demonstrate that more wheat is produced annually than is consumed

annually. On July 1, 1931, the world carry-over of wheat was estimated at 679,000,000 bushels, as compared with 578,000,000 bushels on July 1, 1930. These figures include, for the United States, an item not formerly included, namely, an estimate of wheat stored by mills for other interests. Leaving out this item, and estimating the carry-over on the old basis, the world's carry-over on July 1, 1931, was 659,000,000 bushels, as against 569,000,000 bushels on July 1, 1930.

World production of wheat this year will be less than last year's, but the difference will not make a large cut in the carry-over into next year. As now estimated, world wheat production for 1931 is reckoned at from 200,000,000 to 300,000,000 bushels less than the output in 1930. This country's crop shows an increase (884,280,000 bushels, estimated on October 1, as against 863,430,000 bushels harvested in 1930); but the production is lower in Canada, Russia, Argentina, Australia, and parts of Europe. The Northern Hemisphere (outside Russia and China) has an indicated output of 3,250,000,000 bushels, as against a harvested production of 3,314,000,000 bushels in the same area last year. Relative to the reduced demand by importing countries, the world's wheat surpluses this year have thus far been more burdensome than they were last year.

World Consumption of Wheat

Many farm commodities are low in price just now because demand has fallen. The demand for wheat has fallen too, because importing countries lack the purchasing power to maintain their imports at the usual level. But wheat consumption has not declined as much as the consumption of some other farm commodities. In hard times poor people eat relatively more cereals, and cut down on other things. World consumption of wheat has grown steadily in the last 10 years. In the 1930-31 season, total apparent disappearance of wheat outside Russia and China (for China consumption statistics are not available) was 3,800,000,000 bushels, as compared with only 3,200,000,000 bushels in 1921-22, and also in 1922-23. The consumption in 1930-31, a depression year, was well above that of the preceding year, and about equal to that of the highly prosperous season 1928-29.

The main trouble with wheat has not been a declining consumption but a too rapidly mounting production. This conclusion is not set aside by the fact that the world's wheat output this year will be somewhat less than it was in 1930-31. It is the trend that counts. Wheat growers are suffering from the maladjustments of two decades. The burden falls heaviest on the wheat-exporting countries. Wheat-deficit countries can protect their wheat growers by tariffs, embargoes, and milling restrictions.

In the years of industrial expansion and thriving trade that preceded 1930, the weakness of the world's wheat industry was masked. Prices were high enough to keep poor land in production, and to make good land profitable. In the seven years ended July 1, 1930, No. 2 hard wheat at Kansas City averaged \$1.28 a bushel. Despite warnings, farmers thought they were safe in expanding their production. They attached insufficient importance to world-wide increases in wheat acreage and in wheat carry-overs, and to the import-restriction policies that betokened distress in wheat-deficit countries. Economic depression brought the underlying trouble to a head. The combina-

tion of world overproduction and business depression resulted in extremely low prices. For the United States as a whole, the farm price of wheat as of October 15, 1931, was only 36.1 cents a bushel, as compared with 65.6 cents on October 15, 1930. There was some recovery in October and early in November. In the pre-war period 1910-1914, the average farm price of wheat was 88.4 cents. Farm expenses of production and living costs are much higher than they were before the war. Debt and taxes are much greater. Hence prevailing wheat prices are literally ruinous.

United States Farmers Aided by Farm Board

Our own wheat farmers suffered less than those of the other principal wheat-exporting countries in the wheat-price slump, because from the middle of November, 1930, to the middle of June, 1931, the Federal Farm Board maintained prices in the United States at a level well above the world market. No Government agency, however, can support wheat prices indefinitely against pressure of the sort that has come against them in the last two years. Surplus production and lack of purchasing power in the principal importing countries make an insuperable obstacle. Therefore it is encouraging to note that various countries are beginning to reduce their wheat acreage. The wheat acreage was reduced this year in the United States, Canada, Argentina, and Australia. Though the reductions were brought about partly by adverse weather conditions at seeding time, the price situation was not without influence. Russia shows no disposition to join the movement. Wheat growing in Russia, moreover, is carried on in such a way that plantings do not respond to world prices as do plantings in other countries. This is a factor with which wheat growers in all other countries must deal. It means that their readjustment problem will be more difficult than it would be if Russia could be counted on to behave as other countries do when markets fall. But no country can continue to produce for export indefinitely at a loss. Russia, too, must eventually count all its costs of production. It is not probable they are less than those of the more favorably situated wheat-producing areas elsewhere. In the United States it seems desirable further to reduce the acreage in wheat in all areas where costs of production are relatively high. When surplus stocks have been absorbed and excess acreage withdrawn from production, and when various elements in production costs and handling costs have been adjusted to the prevailing lower price level, our wheat industry should again be prosperous though reduced in size.

COTTON SITUATION

Cotton prices fell at the beginning of the 1931-32 season to the lowest point touched since 1898, with no proportionate decline in the farmers' costs of production. As a result, the situation of the cotton growers became as serious as it had ever been in the history of the country. The difficulty sprang from circumstances long in preparation, as well as from the prevailing world depression. About 10,000,000 acres were added to the cotton area of the United States after the war, and methods were developed for combating the boll weevil. The increased acreage, combined with increased yields per acre, enabled the United States to produce large cotton crops under average con-

ditions. In exceptionally favorable seasons, it produced cotton excessively.

Meantime foreign countries, responding to the stimulus of the previous cotton shortage, expanded their production. India, Egypt, and Russia enlarged their output greatly, and other countries began growing cotton. Foreign cotton spinners encouraged these developments, which coincided for some years with large world consumption. Hence the cotton market did not feel any depressing effect immediately. But the inevitable reaction was merely postponed. Despite an increased industrial demand for cotton in the United States, more than half the American crop had to be sold abroad. It came into competition with cheaper foreign cottons, which foreign spinners purchased in an increased proportion to their total requirements. When importing countries reduced their takings on account of disturbances in the market for cotton goods, it became apparent that cotton growing was over-expanded. Great Britain, the largest foreign consumer of American cotton, lost trade in cotton manufactures owing to the development of cotton-textile manufacturing in other countries, and also as a result of the Indian boycott on foreign goods. Some of the countries that expanded their cotton-textile manufacturing specialized in the cheaper foreign cottons, to the obvious injury of our cotton export trade.

Downturn Preceded Depression

These influences had noticeable effects nearly a year before the present world depression started. Cotton exports from the United States fell off in the latter part of the 1928-29 cotton marketing season. Germany's textile industry, which had been fairly active, became almost as depressed as Great Britain's, and textile manufacturers in other countries of central Europe found the going hard. It is thus evident that the slump in the world's trade in 1929 did not cause, but merely accentuated a disparity between the production and the consumption of cotton. World consumption of cotton at the rate attained in the postwar period of industrial activity could not last, because it was not backed up by sufficient buying power in the cotton-importing countries. Europe in particular could not export enough goods to pay for its imports, and the balance had to be struck in credit. When this could no longer be satisfactorily done, cotton consumption had to decline. Economic difficulties elsewhere made matters worse. China's demand for cotton was restricted by the fall in the purchasing power of silver. Russia, which for some years had imported American cotton, is using home-grown cotton almost altogether and during the past season had some left for export. Cotton consumption dropped everywhere as the depression gathered force, and cotton stocks accumulated.

Prices naturally declined. In order to check the movement the Federal Farm Board formed a Cotton Stabilization Corporation, which bought and stored about 1,300,000 bales of cotton. The Farm Board also loaned money on cotton to cotton cooperative associations. Nevertheless Middling $\frac{3}{8}$ -inch cotton at the close of the 1930-31 season sold, at 10 principal markets, at an average price of less than 8 cents per pound. For the entire 1930-31 season the price at these markets averaged 9.61 cents per pound, as compared with 15.79 cents in the

1929-30 season and 19.72 cents in the 1927-28 season. Though the consumption of cotton in the United States increased as the 1930-31 season progressed, total domestic consumption for the season was only 5,271,000 bales, as against 6,106,000 bales in 1929-30 and 7,091,000 bales in 1928-29. Exports of cotton in the United States in the 1930-31 season were only 6,760,000 bales, as compared with 8,044,000 bales in the 1928-29 season. Foreign cotton consumption did not improve in the early months of the present season, which began with a world carry-over of American cotton that was the second largest on record. The supply for the 1931-32 season is well above the previous record supply of 1926-27 and more than twice as large as the world's consumption of American cotton in 1930-31.

Farmers Were Forewarned

This disastrous situation did not fall upon the farmers without warning. In the fall of 1930 the Department of Agriculture issued a special outlook report for the Southern States in which developments affecting the cotton situation were considered in detail. The report drew attention to "certain long-time developments which may necessitate adjustments in production over a period of years." It urged the advisability of considering the problem before adjustments were forced upon the country. This recommendation, with various facts about cotton conditions at home and abroad, was carried to farmers through Federal, State, and private agencies. Acreage planted to cotton in 1931 was reduced, as were production costs. Though the acreage reduction did not suffice to strengthen the cotton market, or the reduced expenditures to make the crop profitable, it indicated a definite response to "outlook" information.

In adjusting the production of cotton to market requirements, there is no question of withdrawing from the foreign market. American growers can compete with foreign producers, and cotton is generally more profitable or less unprofitable than other crops that can be grown in the South. During the first rapid spread of the boll weevil, this country's power to retain its position in the world's cotton trade was questioned. It has since demonstrated its ability to hold its place in spite of the boll weevil, and in the face of increasing foreign competition. The immediate need is not further evidence that cotton can be grown abundantly in the United States, but more attention to means of reducing production costs and improving the quality of the crop, while at the same time its volume is adjusted more nearly in harmony with the world's demand. Land that can not grow cotton profitably under average conditions should be eliminated from cotton growing. Efforts should be continued to improve the staple and the spinning qualities of cotton. The department is conducting research on these and allied problems. Further study should be given to the problem of making premiums for superior cotton available to growers at country markets. Substantial progress in this direction has been made in recent years, through the work of public agencies and farmers' cooperative associations.

LIVESTOCK SITUATION

Livestock producers at the beginning of 1931, like the producers of other agricultural commodities, were faced with the problem of marketing their products under adverse conditions. With domestic and

foreign demand greatly reduced, sharp price recessions were necessary to move the market supply of meat.

Supplies of livestock, other than sheep and lambs, marketed during the year were not excessive for normal conditions, but as a result of the reduced consumer demand, returns to producers for all classes of livestock were much smaller than those of 1930 and were probably the smallest for any year since 1911. The total live weight of livestock slaughtered under Federal inspection during the first half of the year, amounting to 10,333,000,000 pounds, was only about 2 per cent larger than the relatively small volume slaughtered during the corresponding period in 1930, but the total amount paid by slaughterers for such stock was 28 per cent less.

In other words, total expenditures by slaughterers for these animals dropped from \$1,006,000,000 during the first half of 1930 to \$723,000,000 during the first half of 1931. Of this reduction of \$283,000,000, about \$150,000,000 was on hogs, \$112,000,000 on cattle, \$12,000,000 on sheep and lambs, and \$9,000,000 on calves. Farm prices of livestock in August averaged 23 per cent lower than those of a year earlier, whereas grain prices were down about 47 per cent, cotton prices 44 per cent, prices of fruits and vegetables 35 per cent, and those of dairy products 26 per cent.

Cattle numbers on farms have had an upward trend since 1928 but 1931 was the first year since 1926 in which cattle and calf slaughter was larger than in the previous year. During the first half of 1931, 2.8 per cent more beef and 7.4 per cent more veal were produced under Federal inspection than in the corresponding period in 1930; steer slaughter, amounting to 2,151,000 head, increased by 155,000 head, or 8 per cent. Low prices caused the holding back of many cows that would normally have been marketed, and cow and heifer slaughter, totaling 1,625,000 head, fell off 100,000 head or 6 per cent. The ratio of steer slaughter to total slaughter was relatively higher in June than in any previous month of the year, indicating that reduction in dairy herds by slaughter was still relatively light. Midsummer reports from dairy men indicated that the supply of such cows going to market during the last half of 1931 would be considerably larger.

Declines in Livestock Prices

From the first week in January to the last week in May the decline in the weekly average price of different grades of steers at Chicago amounted to \$5.50 per hundred pounds on choice, \$4 on good, \$2.40 on medium, and \$1.60 on common. An unusually high percentage of the better grades in the supply tended to accentuate the decline on these grades. The average price of slaughter cattle during the first six months of 1931 was \$6.61, as compared with \$9.74 and \$11.04, respectively, during the corresponding periods of 1930 and 1929. The average price of calves was \$7.88 during the first half of 1931, while it was \$10.85 and \$13.17 in the corresponding periods of 1930 and 1929.

Prices of the better grades of steers and heifers advanced materially between the first of June and the end of August, but prices for the lower grades of cattle were only slightly higher at the end of this period than at the beginning. The decline in stocker and feeder prices in June, when stocker and feeder shipments into the Corn Belt were the smallest for the month in at least 13 years, reflected a widespread lack

of confidence in future cattle prices, poor pastures in the Middle West, and poor range and feed prospects in some Western States. As a result, the estimated number of cattle on feed in the Corn Belt on August 1 was 13 per cent smaller than on that date in 1930. With two years of unprofitable cattle feeding to look back upon, Corn-Belt feeders reported a considerable decrease in the number of cattle they expected to purchase in the fall of 1931 despite the prospects of a large supply of cheap feed. It is probable, however, that the August advance in the prices of the better grades of fed cattle will result in a stronger feeder demand late in the season than was indicated by the August 1 report.

Nevertheless, the relative economic position of the cattle industry as compared with that of most of the alternative agricultural enterprises remained as favorable as when prices were on a much higher level. The farm price of beef cattle in July was 66 per cent of the 1925-1929 5-year July average. Corn, butter, and hog prices were 58 per cent, lamb prices 38 per cent, and wheat prices 35 per cent of their respective July averages for that period. In 1930 the per capita supply of beef and veal from total slaughter was the smallest in the 31 years for which records are available. The per capita supply for 1931 will not be materially larger.

Hogs Bring Lower Returns

The number of hogs on farms has declined in recent years. The total of 52,323,000 on January 1, 1931, was about 8,300,000 less than on that date in 1928. Federally inspected slaughter was reduced from 49,795,000 head in 1928 to 44,266,000 head in 1930. Slaughter in the calendar year 1931 may not differ greatly from that in 1930, but the number slaughtered during the crop year ended September 30, 1931, showed a reduction of about 5 per cent. A reduction of 1 per cent in the number of hogs slaughtered under Federal inspection during the first half of 1931 was more than counterbalanced by an increase in the average weight. The total dressed weight of 4,100,000,000 pounds was 1.2 per cent larger than the relatively small production during the corresponding period in the year previous. The average price paid by slaughterers for these hogs was \$7.05 a hundred pounds, as compared with \$9.90 paid in the first half of 1930. This is a reduction of 29 per cent.

Hog prices declined steadily from October, 1930, to February, 1931. After a temporary seasonal rise in March, the decline was resumed in April and was not checked until early June, when new postwar lows were established despite the fact that slaughter supplies were the smallest for May in five years. There was a reduction of 1,273,000 head in Federal-inspected slaughter during May, June, and July. Yet the summer seasonal rise in hog prices was relatively small, and was completed by August 1. Prices declined sharply through that month and at the beginning of September were at the lowest level since 1908. Nevertheless the relationship of feed prices to hog prices continued favorable for hog feeding, and the 1931 spring pig crop was increased 2.5 per cent. A large increase in the fall crop was indicated.

Foreign demand for hog products was relatively weak. Hog producers in central Europe and Denmark have greatly expanded their pro-

duction in recent years. Although total exports of hog products in 1930 were smaller than in any previous year in the present century, a further reduction occurred in 1931. Exports of lard in the first half of the year were 18 per cent smaller and those of pork 47 per cent smaller than in the first half of 1930.

Record Slaughtering of Sheep

Sheep on farms in the United States have increased in number every year for the last nine years. At the beginning of 1931 the country had the largest number of sheep and lambs on record. There were approximately 16,000,000 head more on January 1, 1931, than on January 1, 1922, the low point in the present production cycle. This was an increase of 44 per cent. During the last seven years the estimated annual lamb crop of the United States has increased about 1,500,000 head each year. The total of 31,684,000 head, estimated in 1931, was almost 10,000,000 head larger than the crop of 1925. Inspected slaughter increased about 53 per cent between 1922 and 1930, or from 10,929,000 head in the former year to 16,696,000 head in the latter. Because of population growth, however, the per capita supply of lamb and mutton increased only from 5 pounds to 6.6 pounds, or only 32 per cent. New high monthly record slaughtering under Federal inspection have been made in every month but two (November, 1930, and March, 1931) since January, 1930. Per capita consumption during 1931, however, will probably be somewhat smaller than the record of 8.1 pounds in 1912.

Despite increasing market supplies each year, sheep and lamb prices remained relatively high from 1922 to 1928 inclusive. In April, 1929, however, a sharp downward trend began, which was not checked until October, 1930. Prices were fairly stable during the last three months of 1930, and advanced moderately during the first three months of 1931. The trend has been downward since April. Farm prices of lambs in July were lower than in any other July since 1911. Farm prices of sheep in July were the lowest for any month since records of farm prices were started in 1910. Market prices for aged ewes were so low that returns would sometimes barely cover marketing costs. Large numbers of such ewes were held back, and lambs made up an unusually large proportion of the slaughter supply.

Wool

The wool clip of the United States increased in 1931 to 368,000,000 pounds, or 7 per cent more than in 1930. Preliminary estimates indicate that the world clip for the year will be almost as large as the record clip of 3,210,000,000 pounds shorn in 1928. World stocks of wool are large. Wool consumption by woolen mills in the United States during the first half of 1931 was considerably larger than in the first half of 1930, but no significant increases in consumption have yet been reported by mills in European countries. A downward trend in wool prices started in 1928. It continued with few interruptions into 1931. Recently increased activity in the wool-textile industry of the United States has brought a strengthening of domestic wool prices.

DAIRY SITUATION

The sharp declines in prices of dairy products which began late in 1929 continued well into 1931, and incomes from dairying were drastically cut. This situation obliged dairymen to consider their production programs carefully and to undertake desirable readjustments. From its nature, however, the dairy industry can be readjusted to changing market conditions only very slowly, and production is still high. For quick relief dairymen are doing what they can to reduce their costs and to develop supplementary sources of income. Meantime they are instituting long-time production adjustments by culling out low-producing animals, and by decreasing the proportion of heifers in their herds. Though this procedure may not have noticeable effects on dairy prices for some time, it is permanently constructive and will unquestionably have important beneficial results eventually.

The number of dairy cows in the United States has increased gradually since 1900. There were 2.4 per cent more milk cows on farms on January 1, 1931, than a year earlier. Moreover, the number of yearling heifers exceeded the number required for normal replacement. Nevertheless the prevailing low prices for dairy products may bring about substantial readjustments. As already noted, dairymen show a disposition to raise fewer dairy heifers. The ratio in 1931 of heifers 1 year and 2 years old to the number of dairy cows decreased. This decrease was a reflection to some extent of the unsatisfactory price situation. The number of dairy cows on farms will probably not increase as greatly in the near future as it has done in the recent past.

Other Readjustment Possibilities

Other readjustment possibilities exist. Dairy production depends materially on the relation between feed prices and the prices of dairy products. Just now feed prices are low as well as the prices of dairy products. Hence, the relationship is still not unfavorable to dairy production. Improvement in grain prices, however, would soon make it less favorable. Another possibility of change lies in the fact that dairying is very closely associated with beef-cattle production in certain parts of the country. Indeed a large part of our total dairy output comes from areas that draw no sharp line between dairy cattle and beef cattle. When the beef-cattle industry is depressed, dairy output in these areas increases. With improvement in the beef situation, a shift in the opposite direction takes place. Slaughter of dairy cows and heifers was relatively low in the first half of 1931. Recently it has increased. Reduction of dairy herds by slaughter should strengthen the dairy industry materially. As other branches of agriculture come into a better relationship to their markets, pressure upon dairying will be relieved. Such pressure is heavy in periods of depression because dairying more than any other farm enterprise is resorted to as a source of cash income to meet current expenses.

Until the onset of the depression in 1929, the demand for dairy products in the United States had risen quite steadily for a number of years. Since then it has fallen off. Consumption of fluid milk has dropped, and consumption of manufactured dairy products has not increased appreciably despite heavy price declines. The dairy surplus has gone mostly into butter, and the butter markets have carried much

of the burden. Butter production in 1930 was not excessive because of the drought. In fact it barely equaled the production of 1929. In the early part of 1931 butter production was unusually heavy. It declined somewhat during the summer months, during which period drought again prevailed in some important butter-producing areas. Total production of all manufactured dairy products this year has been somewhat less than it was in 1930. Hence, the underlying supply and demand situation suggests improvement.

Reserve stocks of dairy products have been reduced greatly. Cold-storage supplies of butter and American cheese on September 1 were the lowest for that date since 1923, and stocks of condensed and evaporated milk held by manufacturers were the lowest for that date in the last three years. This decline in current supplies tends obviously to support the dairy markets, but in the conditions now prevailing it is not doing so to the degree that it would in better years. One cause is an extremely conservative buying policy among the distributors of dairy products, who do not know how consumption might be affected by price advances. Improved business conditions would undoubtedly cause an increase in the consumer demand for dairy products; but in the present condition of the dairy industry such an increase could easily be offset by an increase in dairy production. Improvement depends largely on the restoration of better demand conditions. Production power is so elastic, however, that much depends on action taken by the dairy industry. With the number of dairy cows increasing, it is comparatively easy to expand dairy production. Restraint is necessary if the dairy industry is to improve when business and agriculture generally improve.

POULTRY SITUATION

Poultry men faced unusually perplexing problems. Poultry production gave relatively better returns than egg production. Excessive stocks of eggs were stored in 1930, and egg prices remained low during the storage season. Storage operators lost heavily. In consequence, they followed this year a cautious policy which tended to keep egg prices down. Prices to producers for eggs during the first eight months of 1931 averaged below those for any similar period since 1910. Curtailed hatchery operations reduced the size of the new poultry crop by fully 8 per cent, and there was close culling in farm flocks. The number of laying hens in farm flocks was reduced below the number last year and below the 5-year average for the period 1925-1929. On the other hand, liberal feeding of grain and poultry feed caused relatively high egg production per hen. Total production of eggs during the summer and early fall was heavier than had been expected, and storage stocks of eggs increased. Total stocks of both shell and frozen eggs on September 1 exceeded the 5-year average. Meantime lessened consumer buying power tended to check consumption. As a result the usual fall seasonal rise in egg prices was below normal.

Prices to producers for chickens averaged lower this year than in any year since the war. Feed costs were low, however, and the returns to producers were generally more satisfactory than in other lines. As the year advanced the spread widened between the cost of poultry rations and the market prices of poultry and eggs. Close culling of flocks, smaller farm consumption of poultry, and liberal feeding furnished the markets with a steady supply of poultry, which was exceptionally well

finished. Consumption of poultry was remarkably well maintained, and storage stocks until early fall were relatively light. Poultry prices were profitable to storage operators during the first half of the year. Heavy marketing of poultry developed in July, however, and the market situation became less favorable.

FRUIT AND VEGETABLE SITUATION

Prices of fruits and vegetables this year, with few exceptions, declined to levels much below those prevailing in 1930. Late lettuce was an outstanding exception. Pears, owing to light production, resisted the downward trend fairly well. Potatoes and peaches were extremely cheap. Peach production was a record. Apple production was large, and apple prices correspondingly low. The August forecast indicated the heaviest crop since 1926. Output of cantaloupes and similar melons in eight late-producing States was about 6 per cent more than in the previous season. Grape production, on the other hand, was reduced by hot weather, and was estimated at 28 per cent below the production of 1930. In 10 late-shipping States the output was estimated at about 12 per cent below the production in 1930. Drought conditions in Florida ended in July, and the prospects for oranges and grapefruit in that State improved. In California, though high temperatures prevailed, the fruit was sufficiently advanced in September to prevent shedding or serious injury. Output of water-melons in 16 late States was estimated at 36 per cent more than in 1930. Potato production was substantially larger than in 1930, particularly in the Northeastern States. Sweetpotato production was estimated in August at about 30 per cent above the output of the previous year. Production of onions in 17 States was about 31 per cent less than in 1930. Tomato production in 14 late-producing States was nearly 20 per cent greater than in 1930. Excessive production in many lines and low prices brought about an unusual number of bankruptcies in the fruit and vegetable trade, and net returns to growers were small.

Growers had the advantage of some decrease in fertilizer prices and in wages. On the other hand, diminished demand lowered prices for some of the less desirable sizes of fruits and vegetables to a point below harvesting and transportation costs. Shipments of No. 2 potatoes from the South Atlantic States were relatively small, and the prices received even for No. 1 potatoes were unprofitable to most growers. In the Imperial Valley of California cantaloupe production was enormous, and the quality of the crop was fully up to the average; yet cantaloupe prices were so low that the year was considered the most disastrous in the history of California's cantaloupe industry.

Heavy Losses to Growers

It proved impossible, from the beginning of the season, to realize the costs of packing and marketing small-sized plums on the Pacific coast. The same was true of peaches in Georgia. In both these areas considerable quantities of fruit were not moved. Marketing outlets for canned goods were restricted. Cannerymen and dealers began the season with unusually large carry-overs, particularly of peaches. Accordingly, California cannerymen limited their pack for the current year. This involved heavy loss to the growers. Overproduction of yellow

cling peaches for canning had become chronic in California. Canners' and growers' organizations cooperated this year in a new method of adjusting production to demand whereby marginal orchards were destroyed under an arrangement involving payment at a relatively low rate per ton for fruit on the trees provided the trees were uprooted before the crop was ready for harvesting.

This outstanding example of economic readjustment to market conditions followed recommendations offered four years ago by Federal and State officials. The overplanting of cling peaches was emphasized by the so-called peach war of 1927, in the course of which the entire crop of Tuskenas (Tuscans) was permitted to go to waste while growers and canners argued over prices. When Federal and State officials recommended the systematic removal of enough acreage to bring production into line with the demand, with the operation financed by contributions from the entire industry, the proposal met with much criticism. To-day it is in process of accomplishment. It should enable growers to avoid the usual process of adjustment through bankruptcy and permit the preservation of the better orchards. Similar plans to solve the surplus problem of the grape industry have been under discussion. A remedy is needed urgently because the demand for juice grapes has decreased in the Eastern States and the production of table and raisin grapes has continued to increase. So serious have been the resulting difficulties of the grape industry that many owners have lost their vineyards.

EXPORTS AND IMPORTS

The value of our agricultural exports in the fiscal year ended June 30, 1931, amounted to only \$1,038,000,000. This was a reduction of \$457,867,000 from the total of the preceding fiscal year, and was the lowest for any year since 1911. In volume our agricultural exports have declined about 25 per cent in the last two years. Most of this decline took place in the 1928-29 season, but meat products suffered most in the 1930-31 season. Exports of fruit products were greatly reduced in the 1929-30 season, but recovered in the 1930-31 season. Exports of tobacco have been well maintained through the depression.

The percentage of agricultural production exported declined between 1928-29 and 1929-30 from 12.2 to 10.2 per cent, and probably declined more in 1930-31. In 1919-20 the United States exported about 17.4 per cent of its agricultural production. The depression in 1921 brought the proportion down to 13.5 per cent. There was some recovery; and in 1924-25 the ratio was 16.1 per cent. Since then the trend has been downward.

Cotton has suffered most from the reduction in foreign demand. Exports of cotton excluding linters declined from 8,520,000 bales in the 1928-29 season to 7,096,000 bales in the 1929-30 season and 7,048,000 in the 1930-31 season. The reduction in volume was accompanied by a much greater reduction in value. In the 1930-31 season the value of our cotton exports was only 56 per cent of their value in the 1928-29 season.

Exports of wheat, including flour in terms of wheat, declined from 163,687,000 bushels in the 1928-29 season to 153,245,000 bushels in 1929-30 and 131,536,000 bushels in 1930-31. The volume of our wheat exports in the 1930-31 season was 14 per cent less than in the

previous season, and the value 38 per cent less. A short corn crop in 1930, as well as unfavorable foreign conditions, resulted in a great reduction also in the exports of feed grains.

Exports of meat and meat products have been greatly reduced. Exports of total meats decreased 35 per cent in the 1930-31 season, as compared with the previous season. The main decline was in pork products. Bacon and Cumberland sides fell off 61 per cent, from 132,-967,000 pounds in 1929-30 to 52,412,000 pounds in 1930-31; hams and shoulders dropped 23 per cent, from 130,318,000 to 99,749,000 pounds; fresh pork decreased from 18,768,000 to 11,093,000 pounds, or 41 per cent; pickled pork was reduced by 47 per cent, from 39,809,000 to 21,118,000 pounds. Fresh pork exports were the lowest since 1914-15; exports of pickled pork had not been so small since 1851. The lowest intervening year was 1869, when the amount was 24,000,000 pounds. Exports of bacon were the lowest since 1870, in which year they were 39,000,000 pounds. Export of hams and shoulders were the lowest since 1894, except in 1910-11, when they were 58,000,000 pounds.

Exports of leaf tobacco declined only slightly from 587,125,000 pounds in 1929-30 to 566,036,000 pounds in 1930-31. The decrease was general in all classes except Maryland and Ohio Export, which increased 29 per cent.

Increased Exports of Fresh and Dried Fruits

Considerable increases were recorded in the exports of fresh and dried fruits. Exports of dried apples were 38,121,000 pounds, as against 23,-769,000 pounds in the fiscal year 1929-30. Export movement of dried prunes jumped to 296,254,000 pounds from 142,989,000 pounds the previous year. Exports of dried fruits for salads totaled 14,518,000 pounds, as against 1,332,000 pounds the previous year. Exports of fresh apples were 6,780,000 barrels, as compared with 3,426,000 barrels in 1929-30. Exports of fresh pears rose to 134,670,000 pounds, after a decline to 62,024,000 pounds in 1929-30. Exports of oranges and lemons were about the same as in the previous year; and there was an increase of 43 per cent in the quantity of grapefruit exported.

Exports of canned vegetables declined 33 per cent in both quantity and value. Exports of vegetable oils decreased in both quantity and value. Cottonseed-oil exports (crude and refined) fell from 31,998,000 to 26,353,000 pounds, with a decrease of 20 per cent in value; linseed-oil exports dropped from 2,129,000 to 1,298,000 pounds, with a 51 per cent decrease in value; soybean-oil exports were 4,410,000 pounds in 1930-31, as against 5,509,000 pounds in 1929-30.

Imports of agricultural products (excluding forest products and rubber) were reduced in volume and value. For the season July 1, 1930, to June 30, 1931, they amounted to \$1,067,000,000, a decrease of 37 per cent from the total of the preceding year. The value was the lowest since 1914-15. Imports of animal products were greatly reduced in both volume and value. The value of imported dairy products was reduced 47 per cent; of imported eggs, 67 per cent; of imported hides and skins, 53 per cent; of imported meat and meat products, 71 per cent; of imported silk, 37 per cent; and of imported wool, 59 per cent.

The quantity of coffee imported increased, but the value decreased. Imports of sugar and tea declined slightly in value. A great reduction

in the value of sugar had taken place before the present depression began. Imports of vegetable oil and oilseed products decreased in value. The volume of the imports of unmanufactured tobacco increased, but a decline in prices reduced the value 21 per cent from 1929-30.

SIGNIFICANT POPULATION CHANGES

Farm population in the United States showed a net increase in 1930 for the first time since 1922, when the department began making annual estimates of the number of people living on farms. From other data it appears that the indicated increase in our farm population last year was the first annual increase in two decades. For January 1, 1931, the estimate of farm population was 27,430,000, as against 27,222,000 on January 1, 1930. During 1930, it is estimated, 1,543,000 persons left the farms, as compared with 1,876,000 the previous year. On the other hand, 1,392,000 persons went from cities to farms in 1930, as against 1,257,000 in 1929. Hence the net movement from farms to cities was only 151,000 in 1930, as compared with from 576,000 to 1,120,000 in the other years since 1921. On farms, however, there is a considerable surplus of births over deaths. The surplus in 1930, it is estimated, was 359,000 persons. Balancing the gains and losses for the year, leaves a net gain in farm population of 208,000 persons.

Unemployment has greatly reduced the flow from farms to cities and has stimulated somewhat the movement of city people in search of the cheaper conditions of livelihood to be found in the country. It is, of course, impossible to say on the basis of the figures for a single year whether or not the tide has turned. Urban unemployment tends to increase the farmward movement, which diminishes again with the revival of industrial activity in cities. Undoubtedly the present trend is fraught with important agricultural consequences. It will increase the difficulty of adjusting farm production to market requirements and will weaken the urban market for agricultural goods. On the other hand it has a good side, for subsistence is more easily got in the country than in the town in periods of trade depression.

Of far greater significance in the long run for American agriculture is the tendency toward a marked decrease in the birth rate in this country and other important industrial countries. In the United States the effect of a declining birth rate is accentuated by restrictions on immigration both directly and through the indirect effects on birth rates and death rates. In the period, 1920-1930, the census reported an increase of about 17,000,000 in our population, or 16 per cent. But the gain was greatest in the early years of the decade. Up to 1923 it was nearly 2,000,000 yearly, after which a steady decline set in. At present the gain is only about 1,000,000 a year. The decrease is attributable partly to a net decline in immigration, partly to a decrease in births, and partly to an increase in deaths. The increase in deaths is due mainly to an increase in the number of elderly people in the population, rather than to a tendency for death to occur at earlier ages. It is estimated that the number of deaths annually will continue to increase because fewer children are being born and fewer immigrants, who are mostly young people, are arriving.

Stationary Population Foreshadowed

From these and other facts, statistical authorities conclude that a stationary population for the United States is only about 30 years distant. Assuming no changes in restrictions on immigration, an increase of about 10,000,000 is expected from 1930 to 1940, of about 7,000,000 from 1940 to 1950, and of only about 4,000,000 from 1950 to 1960. If these estimates prove correct, the population in 1960 will be only about 144,000,000 or about 20,000,000 more than at present.

Significant tendencies exist in urban and rural birth rates. Only four or five of the cities with a population of 100,000 or above have enough children to maintain permanently a stationary population without accessions from the outside. Most cities have only about three-fourths of the number of children necessary to do so. With immigration practically stopped, our cities both small and large depend for their increase mainly on the natural rate of increase of the rural population. Birth rates are declining on the farms as well as in the cities, though not so rapidly. It therefore seems probable that preventing the Nation's population from actually declining may be found to depend on the development of policies that will admit of a large proportion of the population dwelling in a rural environment, even though partly or wholly dependent on nonagricultural employment.

PUTTING LAND TO THE RIGHT USES

Large surpluses of the major farm products point to the probability that for some years little or no expansion of our farming area will be required. For the more remote future the expected drop in the rate of population increase lessens materially the prospective need for additional farm land. The reduced need for new crop and pasture lands and for farm population is emphasized by Europe's striving toward agricultural self-sufficiency. It is also emphasized by increasing foreign competition in the world's agricultural markets. Recent technical progress permits the use of semiarid areas hitherto unsuited for crop production. Increased efficiency economizes both land and labor. Changes in domestic consumption, moreover, are not such as to require a larger crop and pasture acreage per capita.

Whether we consider the foreign or the domestic situation, it seems clear that American agriculture approaches a turning point. There is urgent need to adjust our national agricultural policy, particularly our land policy, to the changing conditions and outlook. Extensive areas of public lands in the United States went into private ownership under the homestead policy during the decade or more beginning in 1913. In the war period, under the influence of high prices, agriculture was further expanded into areas where normal prices could not support it. Although there has been little expansion of our farming area as a whole during the past decade, our 500,000,000 to 600,000,000 acres of unused potential crop land, though mostly of low grade or requiring costly drainage or irrigation, are a constant incentive to overexpansion. Most of the land is in private ownership, and the owners naturally want to get it into use. It would probably be inexpedient and, perhaps, constitutionally impracticable, for the Federal Government to regulate the utilization or settlement of private lands. Much progress, however, could be accomplished through the widespread dissemination of information concerning the long-time outlook for different

lines of production in various parts of the country, and concerning the uses for which particular classes of land are economically adapted. This implies an economic classification of our land resources, which should be readjusted from time to time to conform to fundamental changes in economic conditions. Such a classification would make it easier to discourage ill-advised and unnecessary expansion. It would lessen the risks of new settlement. It would designate land that should be withdrawn from cultivation and land that should be acquired for public uses. It would serve, in short, as the basis of a national land policy.

Replanning of Research Needed

This would require some replanning of the investigational and extension work of the department and the State colleges and experiment stations. Their work would be directed more toward synthesizing research results and coordinating research activities to develop more definite conclusions concerning the economic adaptation of the different kinds of land to various possible uses.

The department has already directed a considerable share of its resources to the study of land utilization. The Bureau of Chemistry and Soils, in cooperation with State experiment stations, is classifying the soils of the Nation and studying their properties. It is investigating the extent, causes, and prevention of erosion. The Bureau of Agricultural Engineering is studying drainage, irrigation, and land clearing. The Bureau of Plant Industry investigates forest pathology. The Bureau of Entomology studies insects that injure forest trees. The Forest Service carries on research in silviculture, forest management, and methods of using timber and timber products; besides administering the grazing facilities of the national forests, it gives attention to problems of range utilization. Recently the Forest Service has expanded its research in the economic aspects of the utilization of land for forestry and grazing. It is studying forest taxation and the disposition of tax-delinquent forest lands. A general inventory is being made of the timber resources of the Nation.

About 10 years ago a Division of Land Economics was established in the Bureau of Agricultural Economics. It has devoted part of its attention to the economic aspects of land utilization. The area of our country is so large, however, that it would have been impracticable for so small a unit to undertake to work out the land-utilization problems of local areas for any appreciable part of the country. A few local studies have been made, mainly with a view to determining the character of the problems of sample areas and developing methods of investigation. The work has been mainly confined to studying the conditions that affect the need for land, and to estimating the extent of the Nation's agricultural land resources available for different purposes.

The time has come when both the Federal Government and the States should devote more attention to the task of determining for specific areas what uses of land are most economical. This is the necessary basis of rural planning. As the proper economic uses of land are determined, a vigorous extension program should be developed to stimulate individuals and communities to adjust their economic life to a sound program of land utilization.

Emergency Conditions Demand Action

Although the attainment of agricultural prosperity will ultimately depend on the development of a more orderly and efficient system of land utilization, it is necessary to approach the problem by dealing with emergency conditions. Economic life in many farm communities has been disorganized by recent changes in the value, utilization, and ownership of land. In some areas many farms have been abandoned. The resources of many communities have been depleted by timber cutting, and unfavorable conditions of the lumber market have reacted on the value of standing timber. As a result, many farmers and holders of timberland can not meet taxes and other carrying charges. Millions of acres of farm or forest land have passed into various stages of tax delinquency. Extensive areas have been taken over by creditors through foreclosure. The fiscal problems of local governments have been intensified, and provisions for schools and other public services rendered uncertain.

In such areas the situation could be clarified through the collaboration of Federal and State agencies in determining the economic outlook for various land uses, and on this basis formulating a program of economic, institutional, and fiscal reorganization. In general, lands now in private ownership should continue to be privately owned and utilized. Where previous conditions have resulted in farms too small or too large for present conditions, reorganization plans should be developed and put in operation with the aid of local business interests and local and national credit agencies.

Utilization By Private Agencies

In certain areas improved methods of forest management, including in some cases the consolidation of scattered tracts and cooperative measures for cutting, handling, and marketing, may permit a profitable utilization by private agencies of timber holdings and wood lots. Profitable private utilization can often be facilitated by changes in methods of taxation or assessment. Probably the Federal Government and the States should assume more responsibility for guiding land utilization and settlement and for determining the feasibility of drainage and irrigation projects. It is probable that assistance may be rendered to farm owners in the more effective disposition of the mineral resources beneath the surface of their farms. It may be desirable gradually to broaden the public acquisition and administration of lands not adapted to private utilization. Recognized objectives in public ownership of land, such as watershed protection, forest demonstration, and the provision of national and State parks and wild-life refuges should not be the only consideration. Other public objectives may well be kept in view. Sparse and scattering occupancy adds to the burden of maintaining schools and other public services. This cultivation of submarginal farm lands increases the competition farmers have to meet, frequently with no advantage to the occupants of the submarginal farms. The maintenance of permanent local forests should be promoted for farming communities needing timber and timber products, raw materials for local industries, local markets, and part-time employment of the population. Lands that can not be privately utilized without excessive soil erosion or

other wastage of natural resources should be removed from private ownership.

The existence of large areas of tax-delinquent land provides an opportunity for broadening the basis of public ownership. Where private ownership is inadvisable, such lands should not be forced into private ownership through resales. What part the Federal Government and the States, respectively, should take in the development of a broader program of public ownership is a matter for future determination. Clearly, however, Federal and State programs of acquisition should be coordinated in harmony with a definite policy of land utilization.

Some Principal Requirements

The central problem is to correct or avoid mistakes in the major uses to which land is put and to safeguard the public interests in the utilization of the land. Summarizing, it seems desirable to—

(1) Encourage farmers who are operating poor land to find better opportunities in agriculture or other occupations. Poor land includes land which, though temporarily adapted to commercial farming, is peculiarly subject to wastage by erosion.

(2) Promote compact communities which will permit maximum economy of schools, roads, and other institutions by encouraging abandonment of areas, especially of poor land, where occupancy has become extremely scattered through abandonment, delinquency, etc.

(3) Create the conditions that will make possible the use for which the land is best adapted, including fire protection for forests, modifications in taxation, consolidation of tracts, and the necessary transportation facilities, and disseminate the requisite technical information.

(4) Insure the maintenance of the forest or range areas requisite for a permanent and stable agricultural economy in regions where agriculture is closely interrelated with forestry, or with use of the range.

(5) Discourage the overexpansion of agriculture.

(6) Prevent the expansion of agriculture into areas poorly adapted for the purpose and the development of a sparse type of settlement that will mean heavy collective costs for public services. This includes discouraging the development of irrigation and drainage by collective action except when agriculturally and economically feasible.

(7) Promote the adjustment of land valuation and the tax burden to what the particular use for which the land is adapted is capable of supporting.

(8) Develop those types of land that will contribute to watershed protection, flood control, adequate provision for future timber requirements, and the protection of range resources.

I consider the land-use program to be of such importance that I have called a national conference of farm leaders to discuss it comprehensively. This conference will be attended by representatives of this department, the land-grant colleges and experiment stations, the Federal Farm Board, State land departments, mortgage companies, farm organizations, railroads, banks, and others.

FARM-LAND VALUES

Developments unfavorable to agriculture during 1930 were reflected by severe declines in farm real-estate values in nearly all parts of the country. Not since 1922 had values dropped in any year to such an

extent as during the year ended March 1, 1931. The index of estimated value per acre for the United States as a whole decreased from 115 per cent of the pre-war level to 106 per cent. The indicated declines were not only more severe than those of the previous year, but also far more general. Only two States escaped reductions in 1930, while in 1924 only 24 had reductions.

The sections reporting the greatest declines in farm-land values, relative to 1930 levels, were the West North Central and West South Central States. Each of these groups of States had declines averaging 11 per cent. The East North Central and South Atlantic groups each reported average declines of 9.4 per cent. The East South Central showed an 8.6 per cent decrease, the Middle Atlantic 4.7, the Mountain States 2, the Pacific States 1.4, and the New England States 0.8 per cent. The States reporting the greatest percentage of decline were Arkansas, North Carolina, Missouri, South Carolina, and Iowa.

Accompanying the downward movement of farm-land values was a general fall in the number of voluntary sales, and a striking increase in the number of forced transactions. During the year ended March 15, 1930, the average number of voluntary sales for the country as a whole was 23.7 farms per 1,000. During the year ended March 15, 1931, the average number dropped to 19 farms per 1,000. Forced sales, on the other hand, increased 25.5 per cent.

An appreciable and rather general demand for farms to rent resulted from the influence of urban unemployment, which caused city people in larger numbers to seek the cheaper food, fuel, and shelter available in the country, and discouraged farm people from moving to cities. Because of the difficulty of financing farm sales, the weak financial condition of the unemployed, and a general disinclination toward buying on a declining market, the accompanying effect on the demand for farms to buy was insufficient either to increase the number of farms sold voluntarily, or to increase appreciably the total number of sales. An increasing proportion of the farms sold voluntarily were bought by men who were formerly tenants, and by nonlocal residents.

Decline Reflects Drop in Earnings

Farm-realty values reflect farm-earning power, current and prospective. Hence, the fundamental cause of the decline in farm-property values in 1930 was the slump in farm incomes. As already noted, gross income from agricultural production in 1930 was about 22 per cent less than in the previous year, though the physical volume of production was only about 2 per cent less. It is estimated that farm-operating costs on the other hand declined only from \$3,152,000,000 to \$2,890,000,000. Wages paid to hired labor declined only slightly and taxes still less. Accordingly, the fall in net incomes was proportionately more than the fall in gross incomes. Net income available as a return for all the capital invested in agriculture, and as a reward for the labor and management of the farm operator and his family dropped to \$4,669,000,000, as compared with \$6,751,000,000 in 1929.

This net income may be considered from two standpoints. If pay for the labor of the farm operator and his family is subtracted at current wage rates for hired labor, there remains only \$573,000,000 as a return for all capital and management devoted to farming. If, on the other hand, adjustments are made for the portion of taxes and operat-

ing expenses paid by landlords, and for payments made by farm operators to nonfarmers for rent and for interest on loans made by them for use in production, the income from production not only fell short by \$346,000,000 of paying farm operators and their families a rate of return for their work equal to that paid to hired hands, but also left no return for the farm operators' own capital and management.

The renewed declines in income came at a time when the readjustment following the 1920 depression was still incomplete. Although land values had begun to show some signs of stability, the amount of land in the hands of involuntary holders was still at high levels, forced sales of farm land still held an unusually prominent place in the real estate market, and long-time financing of agriculture was conservative. The development of 1930 and 1931 have aggravated the situation, and reemphasized the importance of rehabilitated purchasing power for agriculture if further liquidation is to be avoided.

Increase in Tenancy

Along with the increase in the holding of land by involuntary holders which has resulted from the decline in farmers' equities has come an increase in the proportion of tenant-operated farms. This proportion was 42.4 per cent in 1930 for the United States as a whole, as compared with 38.6 per cent in 1925. Increases in tenancy were reported in every State except Connecticut, New York, New Jersey, Pennsylvania, Delaware, Arizona, and South Carolina. Relatively small increases in tenancy occurred between 1910 and 1925. Rapid increases followed the depression of the nineties, partly as a result of that depression and partly because the area of good land available for homesteading was diminishing. During the half century that questions on tenure have been included in the Federal census (1880-1930), the percentage of tenant-operated farms has increased from 25.6 to 42.4. The present high proportion of tenant farms may involve significant consequences to the general welfare, and attention may well be directed to the probable social effects.

TAXES

Farm real-estate taxes showed a slight decline in 1930 for the first time in the 17 years covered by the records of this department. Taking farm real-estate taxes per acre in 1913 as a base represented by 100, the index for such taxes was 249 in 1930, as compared with 250 in 1929. In amount the decline was insignificant, but it indicated a halt in the long upward trend. It did not bring any measurable relief to the farmers because agriculture's capacity to carry the burden declined far more. As we know it to-day, the farm-tax problem is largely a development of the last decade and a half. Taxes increased steadily from 1920 to 1929, inclusive, though farm earnings were low and farm valuations persistently declined. The situation was bad enough before the current depression began. It is critical now.

In the main the farm-tax problem rests with State and local governments, which in many instances are recognizing the fact in practical ways. Forty-four State legislatures met this year, and most of them considered taxation in relation to agriculture. Relief measures advocated, and in some cases enacted, fell broadly in two categories: Those designed to shift part of the cost of State and local government from

general property to incomes and other sources of revenue, and those designed to reduce public expenditures. Property taxes rest principally on real estate; hence farmers and other real-estate owners are generally required to pay more than their fair share. This injustice is coming to be widely recognized, and State income taxes are proposed as a partial remedy.

Idaho, Utah, and Vermont this year joined the list of States having personal and corporate income tax laws. Vigorous but unsuccessful attempts were made to introduce the income-tax principle in several other States. Oklahoma's income tax law was made more effective by an increase in the rates. North Carolina, Missouri, and Wisconsin likewise increased their income-tax rates. Several States increased their gasoline taxes. Some of them arranged to apportion part of the new revenue among minor civil divisions to help defray the cost of local roads. Nearly all of the revenue collected in gasoline taxes in 1929 was devoted directly or indirectly to the construction and maintenance of rural roads and city streets.

Legislative Measures Taken

Practically all the States whose legislatures met this year dealt in one way or another with the problem of reducing public expenditures. Various expedients were adopted. Taxing authorities showed themselves keenly aware that a cut in the amount of the tax burden is as necessary as a more equitable distribution of the load. They were particularly impressed with the growth of tax delinquency. Much land over large areas reverted to public ownership through the inability of its former owners to pay the taxes. In northern portions of the Lake States the tax base of many local governments has shrunk so much that the continued existence of these governments is threatened. Inflexible taxes that take no account of crop failures, price declines, and other causes of distress have precipitated widespread farm insolvency. In such circumstances local budgets have to be pared through sheer necessity, and tax systems must be modified and improved.

Taking the country as a whole, the work of tax reform is barely begun. Nearly four-fifths of all State and local taxes are derived from the general property tax. When real-estate values fall as they have done in the United States since the war, assessments decline much less rapidly, and tend to exceed the current selling value of the land. The necessary twofold remedy, consisting of reduced public expenditure and the development of new sources of revenue, should be invoked for reasons of expediency as well as of justice.

AGRICULTURAL CREDIT

Local farm-credit facilities, barely adequate in normal times, were unprepared to handle the situation resulting from the 1930 drought and recent depression in farm prices. Accordingly, Congress passed legislation to supplement existing credit facilities. It appropriated emergency funds the administration of which was placed in the Department of Agriculture. All told, the final session of the Seventy-first Congress assigned \$67,000,000 for various forms of agricultural credit. It made \$45,000,000 available for loans to farmers who suffered from the 1930 drought. This money was for loans for the pur-

chase of seed, feed for livestock, and fertilizer. An additional \$2,000,000 was appropriated for the same general purposes in a specific area that had suffered from storm and flood in 1929. Another appropriation of \$20,000,000 was made for agricultural rehabilitation (which term included necessary items for farm production) and for loans to individuals to buy stock in agricultural-credit corporations, livestock-loan companies, and similar organizations. Advances made to assist farmers in the drought-stricken areas are dealt with in some detail later in this report. I shall deal here mainly with the other emergency credit provided to supplement the credit obtainable by farmers from other sources, such as the commercial banks, the Federal land banks, the joint-stock land banks, and the intermediate credit banks.

Though much important Federal legislation affecting agricultural credit has been put in effect during the last decade and a half, agricultural-credit conditions generally were extremely unsatisfactory this year. This was not wholly a reflection upon the existing farm-credit facilities. It resulted largely from the depressed condition of agriculture, which weakened banking institutions. More than 1,300 banks in the United States failed in 1930, and 932 failed in the first eight months of 1931. More bank failures in agricultural areas have taken place in the last few years than in any other previous equal period, though the suspensions this year included an increased proportion of city banks. The injury to agriculture was not confined to the loss of deposits; it included a great shrinkage in the amount of agricultural credit available. When local confidence is disturbed, country banks find it more difficult to draw on the larger money centers. Hence their supply of loanable funds comes to depend almost exclusively on their local deposits, which naturally decline if banking conditions seem insecure. In such circumstances, moreover, country banks are obliged to invest an increased proportion of their funds in liquid assets outside their communities as a protection against unusual withdrawals.

Local Conditions the Controlling Factor

Some idea of the extent to which local supplies of agricultural credit have recently been reduced may be gained from the fact that in the middle of 1931 net demand deposits of member banks of the Federal reserve system, located in places of less than 15,000 population, in 20 leading agricultural States, not including California, were about 20 per cent lower than the monthly average for the period 1923-1925. Mainly this decline reflected reduced income from agricultural production. Ordinarily deposits in country banks are a revolving fund available for local loans. When the liquidation of loans made by the country bank is retarded by farm depression, the fund loses its revolving character, and even good credit risks must be refused. Emergency credit provided by the Federal Government materially relieved this difficulty. As mentioned elsewhere, Federal loans to purchase seed, feed, and fertilizer and for agricultural rehabilitation totaled approximately \$47,000,000. In addition the Federal Government advanced \$1,327,000 to individuals for the purchase of stock in agricultural-credit corporations and livestock-loan companies. Loans of this type enabled credit agencies that rediscount paper with the Federal intermediate credit banks to expand their credit facilities by several times the amount of the new capital provided. Hence the full benefit of the advances was much greater than might be supposed from their relatively small total.

Advances of this character, as already noted, were provided for in the \$20,000,000 appropriation for agricultural rehabilitation and loans to individuals to buy stock in credit institutions. Under congressional authority the Secretary of Agriculture, after conferring with officials of the Federal intermediate credit banks and the Federal Farm Loan Board, set aside \$10,000,000 for the latter purpose. A National Advisory Loan Committee, consisting of Lewis T. Tune, chairman, St. Louis, Mo.; B. C. Powell, Little Rock, Ark.; and B. F. Cheatham, Washington, D. C., was appointed to assist in administering the fund. Advisory committees were also appointed in 22 drought-stricken States to make recommendations regarding loan applications. Up to September 1, 1931, advances had been made representing 788 individual loans to stockholders in 49 credit corporations and livestock-loan companies.

Opportunities for Credit Corporations

An important field of usefulness lies open to agricultural-credit corporations in those communities where existing local credit facilities are inadequate. They do not depend for their supply of loanable funds on local sources, but have access to the central money market through their rediscount facilities. Hence they can obtain advances on the basis of actual credit risks without being limited by the necessity of mobilizing funds locally. In 1930 the Federal Farm Loan Board made a regulation authorizing an increase from 2 and 2½ per cent to 3 per cent in the spread allowed agencies rediscounting with the Federal intermediate credit banks. In other words, it permitted rediscounting agencies to charge more for their services and consequently to provide better facilities and better management. With a 3 per cent margin between the rate of interest paid and the rate of interest received, these organizations can function more safely and more efficiently than was formerly possible. This advantage should promote the organization of more agricultural-credit corporations and should help to make capital available to farmers more cheaply and more abundantly. Acting through the Federal intermediate credit banks, they can create new channels through which loanable funds may flow readily from the principal money centers to farm communities.

Varying Interest Spread Needed

A given operating spread might be excessive for local credit institutions in some parts of the country and yet prove inadequate in other areas. Under usual conditions, and even more so at the present time, country banks in the South and West must vary from their customary rates in order to take advantage of the rediscount privileges offered by Federal intermediate credit banks. Few bankers have deemed this a feasible policy. Funds of the Federal intermediate credit banks have hitherto reached farmers principally through agricultural-credit corporations and livestock-loan companies. With the year-round volume of business enjoyed by livestock-loan companies, the present 3 per cent operating spread may prove ample. It is doubtful, however, if it will cover the cost and losses incurred in financing the production of those crops which involve a relatively hazardous and costly type of business. In this type of financing loans are so seasonal that credit corporations can actually earn little more than half the annual rate which is charged.

Limitations on interest rates were authorized by Congress for the protection of farmer borrowers and to prevent exploitation of Federal intermediate bank credit by local credit institutions. The accomplishment in these directions, however, has been overshadowed by the failure of Federal intermediate bank credit to reach farmers in the volume needed. To a considerable extent this appears to be due to the fact that approved spreads have often failed to recognize local operating requirements. In such cases the rate limitations have obstructed the channels through which Federal intermediate bank credit might flow to farmers. A system of spreads, based on variations in local conditions and requirements, would appear to be more practicable than a uniform spread for all areas and types of loans.

Emergency Credit Benefited Many

Congress substantially recognized the principle that agricultural credit should not depend too heavily on local funds when it created the intermediate credit banks. It took an important further step in the same direction in providing the emergency credit here described. The innovation has potentialities only faintly indicated by the extent to which the fund available for capitalizing agricultural-credit corporations has been utilized up to the present. So far less use has been made of the new facilities than was originally expected. Many interested groups had not enough time to obtain subscriptions for stock and to organize operating corporations so as to take care of 1931 crop requirements. Emergency-credit requirements of farmers in the drought area were largely taken care of in other ways, principally through advances from the \$45,000,000 appropriation for loans to purchase seed, feed, and fertilizer. Additional financing through credit corporations was consequently less urgent. Nevertheless much valuable preliminary work was done. The National Advisory Loan Committee devoted much effort to an educational campaign in which radio broadcasting, press releases, and other means were used to acquaint farmers with the advantages of organizing local agricultural-credit corporations. Farmers thus became better acquainted with what they can do for themselves by organizing to rediscount their paper through the intermediate credit banks.

The rapid readjustment which has been forced upon agriculture as a result of the marked decline in farm-commodity prices since 1920 has likewise caused material changes in the usual supply of credit available to farmers. Every effort, therefore, should be devoted to strengthening existing credit agencies, and whenever possible, consideration should be given to such measures as would tend to increase their usefulness.

DROUGHT RELIEF

Excluding the \$10,000,000 set aside to organize new or to strengthen existing agricultural-credit corporations, the department, as already indicated, had \$57,000,000 available for drought relief. More than 385,000 applicants borrowed approximately \$47,000,000 to purchase seed, fertilizer, feed for livestock, and fuel and oil for power machinery, and for agricultural rehabilitation.

Widespread need resulted from the severe drought that prevailed during the 1930 crop-growing season. The worst effects were concen-

trated in a triangular section of the Potomac, Ohio, and Mississippi Valleys running from southern Pennsylvania, Maryland, and Virginia to southern Kansas, to Alabama, and to Texas. Neighboring States felt the drought more or less. How its effects were geographically distributed is indicated by the composite yield per acre of all crops in 17 States principally affected. This composite yield is expressed as a percentage of the average for the 10-year period 1919-1928. It was 87 in Pennsylvania, 73.4 in Maryland, 67.7 in Virginia, 56.9 in West Virginia, 79.3 in Ohio, 84.4 in Indiana, 83.1 in Illinois, 60.5 in Kentucky, 75.6 in Tennessee, 66.8 in Missouri, 62.8 in Arkansas, 89.8 in Kansas, 71.2 in Oklahoma, 86 in Texas, 91.5 in Mississippi, 100.3 in Louisiana, and 111.3 in Alabama. Yields above the 10-year average in Louisiana and Alabama are explained by the fact that only certain sections in those States were drought stricken, and that cotton, their principal crop, withstood the drought surprisingly.

In most of the drought-stricken States gross income from farm production was much below the average for the 5-year period 1924-1928. It ranged from 4 per cent below that average in Pennsylvania to 46 per cent below it in Arkansas and in Oklahoma. In Mississippi the gross income was 39 per cent below the 5-year average, in Texas 37 per cent below, and in Alabama 29 per cent below. Feed production was most affected, wheat and rye and many of the vegetable crops having been harvested before the drought became severe. Rice was not much hurt, since it is grown under irrigation. Pastures were extremely scant. In fact, for the entire 1930 pasture season the condition of pastures in the drought States was only from 50 to 80 per cent of the 10-year (1920-1929) average. Short supplies of grain and hay and poor pastures reduced the output of animal products materially. In the 17 States mentioned, milk production per cow on August 1, when the drought was at its height, was 11.3 per cent below the output on August 1, 1929. Egg production per hen was 9.5 per cent lower. Nevertheless, the production of milk and eggs in these States for the full year 1930, with some exceptions in South Central States, was above the average of the 5-year period 1924-1928, both in total volume and in output per cow and per hen. A mild autumn and winter enabled farmers to economize their livestock feeds, and the drought did not seriously affect the meat supply of 1930. In some areas it temporarily increased market supplies through forced marketing. Beef production in the 17 States was slightly greater than in the previous year; and sheep and lamb production was greater also. The production of calves and hogs declined, but not as a result of the drought.

Much Privation Caused

Statistics, however, give a poor impression of the human side of the drought situation. Tens of thousands of farm families had their savings swept away, and even their subsistence endangered. Usually when weather conditions reduce production prices rise. No such partial compensation came to the drought-stricken areas in 1930 because demand and prices declined under the impact of the world depression. For the little they had to sell farm families got extremely low unit prices. Feeds had to be moved into deficit areas, and in many localities it was necessary also to supply food. Aid was rushed by the Red Cross and by State and local agencies. It was supplemented by Fed-

eral action when Congress, on December 20, 1930, passed the first drought-relief resolution and charged this department with the administration of the funds provided.

Field offices for the handling of applications for loans were established in Washington, D. C.; Memphis, Tenn.; Fort Worth, Tex.; St. Louis, Mo.; and Grand Forks, N. Dak. The making of loans began about February 1, and continued at a rapid rate through the late winter and early spring months. Several hundred temporary workers were employed in these field offices in handling the applications for loans, and valuable assistance was given in the examination of applications by a large number of district agents and specialists from the State extension forces. Loans were made in 1,646 counties in 31 States.

In each county a local seed-loan committee was set up, usually consisting of a prominent banker or other business man and two leading farmers. These committees examined all applications for loans originating in their counties and made recommendations thereon to the department field offices. On approval of the applications for loans at the field office, payment was made to the borrower by check, the transaction in a large proportion of cases being completed in less than a week from the time application was made. As borrowers did not need all their funds immediately on the approval of their applications, payments in many cases were made in two or more installments, as funds were required. These installments were paid only after the receipt of a report from the borrower as to the purposes for which the initial advance had been expended.

All applicants for loans were required to agree to plant a garden, and also a sufficient acreage of feed crops to provide feed for their livestock. This policy was in line with that generally advocated by the agricultural colleges and extension forces in the Southern States, and followed also by many agencies that assist in financing farmers.

Loans from the Various Appropriations

Out of the \$45,000,000 appropriation, 279,466 loans were made aggregating \$39,716,797. Out of the \$20,000,000 appropriation, 91,075 loans for agricultural rehabilitation were made aggregating \$5,430,783. Out of the \$2,000,000 appropriation, 14,651 loans were made, aggregating \$1,908,181. All told, 385,192 applications were approved for loans aggregating \$47,055,761.

As loans were made from the rehabilitation fund to many farmers who had already borrowed from the \$45,000,000 appropriation, the number of individuals to whom loans were made is somewhat less than the total shown. On the other hand, many loans were made to landlords, each of whom financed several farm families, so that the total number of farm families financed was probably between 350,000 and 400,000. The average loan was slightly less than \$150, and in certain States, such as Oklahoma and Kentucky, the average was less than \$100. The small size of these loans shows clearly that farmers generally economized on production expenses and conducted their farming operations in 1931 at the lowest possible cost.

Federal and State extension forces helped farmers, not only in using wisely the money advanced to them, but in utilizing other resources. Farm men and women were urged to plant fall gardens of rapidly maturing vegetables. They were shown how to preserve poultry, beef,

vegetables, and eggs. They were advised about cheap, wholesome foods. As a result the food problem was made less difficult. Meat canning relieved many farmers of the necessity of purchasing feed for their animals, or of selling them at low prices, and at the same time provided a meat supply. Farm women were taught how to renovate and remodel old garments. Practical help was given also in the choice and use of emergency rations for livestock. Farmers were assisted in culling their herds and flocks and encouraged to plant forage crops for fall and spring pasture.

Feed and Forage Supplies Located

Extension agents located supplies of feed and forage, and worked out plans for distributing feedstuffs at the lowest possible cost. County agents helped farmers to get the benefit of reduced freight rates granted by railroads on the movement of hay, feed, and water into drought areas, and on the outward movement of livestock. They and other representatives of Federal and State agencies promoted crop adjustments suited to market needs. In the wheat States they urged the elimination of wheat as a major source of income on farms of poor soil or difficult topography. In the cotton States they emphasized the necessity of a balanced system of agriculture with feed and food crops holding an adequate place in the crop organization.

TABLE 1.—*Loans made to individual farmers in each of the States most seriously affected by drought*

State	From \$45,000,000 appropriation		From \$20,000,000 appropriation		From \$2,000,000 appropriation		Total	
	<i>Number</i>	<i>Dollars</i>	<i>Number</i>	<i>Dollars</i>	<i>Number</i>	<i>Dollars</i>	<i>Number</i>	<i>Dollars</i>
Alabama.....	14, 406	2, 211, 480	3, 812	193, 649	1, 635	267, 438	19, 753	2, 672, 567
Arkansas.....	51, 831	7, 606, 443	26, 675	1, 604, 661	-----	-----	78, 506	9, 211, 104
Georgia.....	13, 231	1, 976, 690	321	14, 503	4, 126	545, 877	17, 678	2, 537, 070
Indiana.....	5, 650	777, 542	388	25, 388	-----	-----	6, 038	802, 930
Kentucky.....	25, 129	2, 247, 645	8, 108	340, 431	-----	-----	33, 237	2, 588, 076
Louisiana.....	15, 392	2, 497, 342	10, 205	693, 093	-----	-----	25, 597	3, 190, 435
Mississippi.....	21, 738	3, 697, 495	9, 868	741, 879	-----	-----	31, 606	4, 439, 374
Missouri.....	15, 029	2, 031, 140	3, 087	271, 642	-----	-----	18, 116	2, 302, 782
Montana.....	8, 027	2, 071, 210	92	10, 030	-----	-----	8, 119	2, 081, 240
North Carolina.....	12, 927	1, 903, 235	3, 436	153, 855	970	153, 912	17, 333	2, 211, 002
North Dakota.....	8, 304	1, 597, 587	-----	-----	-----	-----	8, 304	1, 597, 587
Oklahoma.....	14, 770	1, 397, 372	4, 099	224, 517	-----	-----	18, 869	1, 621, 889
South Carolina.....	536	89, 139	-----	-----	7, 620	895, 009	8, 156	984, 148
Tennessee.....	16, 673	1, 866, 903	7, 394	439, 669	-----	-----	24, 067	2, 306, 572
Texas.....	20, 379	2, 582, 558	9, 178	502, 927	-----	-----	29, 557	3, 085, 485
Virginia.....	16, 467	2, 179, 033	3, 563	175, 134	-----	-----	20, 030	2, 354, 167
West Virginia.....	5, 551	522, 480	495	18, 098	-----	-----	6, 046	540, 578
Total.....	266, 040	37, 255, 294	90, 721	5, 409, 476	14, 251	1, 862, 236	371, 012	44, 527, 006
All other States.....	13, 426	2, 461, 503	354	21, 307	400	45, 945	14, 180	2, 528, 755
Grand total.....	279, 466	39, 716, 797	91, 075	5, 430, 783	14, 651	1, 908, 181	385, 192	47, 055, 761

UNEMPLOYMENT RELIEF

Congress also appropriated large sums to the Department of Agriculture for types of work that contributed to unemployment relief. In most cases the funds appropriated were additions to moneys that would ordinarily have been provided for department activities. In some cases, however, department activities were anticipated by making funds, which ordinarily would not have been available until after July 1, 1931, available during the winter and spring months, for the relief of unemployment. Increased funds were provided for the con-

struction of Federal-aid highways, for roads and trails in the national forests, and for roads traversing the public domain. Various sums were made available to give employment in the repair, construction, and improvement of laboratory buildings, farm facilities, forest-protection facilities, and other equipment used in the department's research and service work. Altogether more than \$100,000,000 was appropriated for objects related to unemployment relief. Emergency employment was directly provided for varying periods for nearly 200,000 men, and indirectly for a much larger number in industries supplying necessary materials and services. Where possible in employing men the department gave preference to the heads of families.

Federal-aid road construction was accelerated as early as April, 1930, when Congress authorized for this purpose an additional \$50,000,000, bringing the total Federal contribution for Federal-aid roads to \$125,000,000 effective with the fiscal year 1932. The actual amount expended in the fiscal year 1931 from the regular Federal-aid highway appropriations was approximately \$135,600,000, including some \$26,000,000 from the \$125,000,000 appropriation for 1932, which was made immediately available. This fund provided work for farmers distressed by the 1930 drought, as well as for unemployed urban workmen. A full discussion of unemployment aid resulting from the enlarged program of the Bureau of Public Roads is given in the next section of this report.

Work in National Forests

Road work in the national forests provided considerable employment. Forest improvement already under way was speeded up, and \$3,000,000 was added to the regular fund for the construction of forest roads and trails. This work created a need for more equipment, such as tractors, graders, power shuttles, compressors, rock crushers, and trucks. In the first half of the current year the department purchased \$145,000 worth of such equipment. Where unemployment was extreme the department rotated available men in construction crews. For the fiscal year 1932, \$800,000 was made available to build a forest products laboratory at Madison, Wis., and \$150,000 for white-pine blister rust control in addition to the usual appropriation for that purpose.

Various measures to relieve unemployment were adopted by the Forest Service. In Arkansas, for example, many farmers living in or near a national forest faced destitution. In this area several hundred men were enabled to support their families by cutting and selling stave bolts. Other men were employed in making silvicultural cuttings to improve the timber growth. For this purpose one forest supervisor disbursed \$12,000 in wages during a 4-month period, giving work to those who needed it most. Construction plans were modified where possible to permit forest road building during the winter. In some places construction crews were alternated. When emergency funds became available for forest improvements action was started in all the national forests and plans made looking toward the progressive equipment of the forests with roads, trails, lookout houses and towers, telephone lines, firebreaks, cabins, barns, inclosed pastures, and drift fences. Comprehensive plans for carrying on such work make it possible to forward it as circumstances warrant. Decentralized organization gives the Forest Service machinery for getting new work under

way rapidly under the supervision of trained local men. As soon as plans for the use of the \$3,000,000 emergency appropriation were completed, allotments to each region were telegraphed to regional foresters and to forest supervisors. Awards for the purchase of equipment followed and in some cases equipment was on the ground within 10 days. By the end of January, 1931, 3,083 men had been given employment under the appropriation; by the end of May the number had increased to 4,558.

Additional funds for emergency improvement by the Forest Service became available under an act approved February 6, 1931, which set aside \$354,800 for insect-control work, forest administration, and range improvements on the national forests. In the regular agricultural appropriation act of February 23, 1931, a provision was included making available immediately certain 1932 appropriations, mainly for forest protection. In June, 1931, the total number of men employed in this work, including those who were given temporary employment through the use of regular 1931 appropriations, was 21,658. By the end of the fiscal year, practically all the emergency funds had been expended or obligated, and about half of the 1932 appropriations made available for use in 1931 had been expended.

Other Emergency Appropriations

The emergency appropriations also included \$300,000 to the Bureau of Biological Survey for the fiscal year ended June 30, 1931, for building dams, fences, telephone lines, electric, water, and septic-tank systems, and cold-storage plants; for surveys of wild-life refuges; and for the control of injurious rodents and predatory animals. About two-thirds of the expenditures made from this appropriation were for personal services. An emergency fund of \$75,000 was provided for the construction and improvement of farm and laboratory buildings required by the Bureau of Plant Industry, and for necessary installations in connection with the field activities of that bureau. An appropriation of \$35,000 was made for construction, by the Plant Quarantine and Control Administration, of a car-fumigation plant at Presidio, Tex. A \$58,000 emergency fund was made available to the Bureau of Animal Industry for construction and development work at its farms at Beltsville, Md., and Miles City, Mont. Employment was furnished by the bureau to many men in clearing land, establishing pastures, building fences, and in constructing laboratories and other buildings. A total of \$87,000 was made available to the Bureau of Dairy Industry for the construction of buildings and other improvements at dairy experiment stations at Beltsville, Md., Woodward, Okla., and Ardmore, S. Dak. Appropriations aggregating \$83,480 were also provided for improvements to the department's buildings in Washington, D. C., including the modernization of its elevator and electrical systems, resulting in additional employment opportunities.

Other bureaus in the department helped to relieve unemployment or to mitigate its effects. The Bureau of Home Economics, for example, prepared economical and healthful food budgets, and carried on necessary educational work, in cooperation with the Extension Service. They cooperated with the American Red Cross in ascertaining the types of help needed and the resources available. More than 750,000 bulletins and posters were distributed in drought and unemployment relief work.

PUBLIC ROADS

Between January and September there were employed on Federal-aid road construction and road construction in the national forests and parks an average of 100,000 men. During this period these men worked the equivalent of 150 days at an average wage of \$4 per day. On this road work, in which the Federal Government participated either as a cooperator with the States or independently, there was paid to labor employed directly on the roads approximately \$60,000,000.

Actually the number of men employed varied during the period from a minimum of 31,000 in January to a maximum of 164,700 in July. By April there were 97,500 at work, and during the active construction season from May to August, inclusive, the number averaged nearly 150,000.

These figures represent the employment offered directly in the construction of the roads. For every person employed directly there are probably at least two indirectly employed in the production and transportation of road materials and equipment. If that be the case, the road-building work in which the department participated occupied an average of approximately 450,000 men during the active season, and the equivalent of 300,000 men for the period from January 1 to September 1, 1931.

The increase in employment offered on Federal and Federal-aid road work this year is indicated by comparison of the 154,450 persons reported as employed directly during June, 1931, with the 64,000 employed during the same month of 1930.

The increased employment afforded by the road work during the fiscal year 1931 is the result of the increased appropriations authorized, the early apportionment of the Federal-aid authorization, and the emergency legislation of December 20, 1930, especially the \$80,000,000 appropriated as an advance to the States to be used by them in lieu of State funds in order to get work under way early in the calendar year 1931. This appropriation is not an outright grant, but merely a loan which the States are to repay over a period of five years by deduction from their future apportionments of regular Federal-aid funds beginning in the fiscal year 1933.

Cooperative Projects Give Greatest Aid

Although the independent Federal construction on national-forest and national-park roads was increased, the Federal-aid road work in which the cost was shared with the States provided by far the greatest amount of employment, and the increase in volume of this work during the fiscal year is the result of three separate actions.

Increased Appropriations

First was the authorization of an additional appropriation of \$50,000,000 for the fiscal year 1931. This addition, bringing the total authorized for the current fiscal year to \$125,000,000, was approved April 4, 1930, and immediately apportioned. It had the prompt effect of increasing the work undertaken during the summer of 1930.

On September 1, 1930, the appropriation of \$125,000,000 authorized for the fiscal year 1932 was apportioned. Normally the apportion-

ment would not have been made until the latter part of December. The advancement of the date added to the amount of work undertaken during the autumn and carried over as the bulk of the work current during the early months of 1931.

Stimulated by the enlarged Federal-aid apportionment, the volume of construction work carried on and completed during 1930 was further increased by the exceptionally long, dry working season. This resulted in an abnormally large expenditure, and left many States with seriously depleted revenues which could not be renewed except by action of the State legislatures. As in many cases the sessions of the legislatures were not convened until after January 1, it seemed probable in December that unless some further action was taken by the Federal Government the resumption of construction work in the spring would be delayed because of a lack of State funds with which to match the available Federal apportionments.

Congress Authorizes Advance in Program

To avoid this possibility Congress, on December 20, appropriated \$80,000,000 to be apportioned among the States in the same manner as the regular Federal-aid authorizations and used by them to match the Federal-aid funds. As it was the purpose to encourage the beginning of work as promptly as possible in order to provide early relief to the unemployed, the amount of the apportioned funds which the States could claim was limited to the amount that should be actually expended by September 1.

This method of stimulating and advancing the construction program proved effective. Within a month \$15,000,000 of the emergency fund and \$14,500,000 of regular Federal aid had been allotted to new projects. The Federal-aid roads under construction, aggregating a little over 8,800 miles at the end of January, increased to nearly 10,400 miles by the end of March. This was virtually as much as the mileage under construction by the end of July of the preceding year; and by June 30, the end of the fiscal year, construction work was in progress on nearly 16,500 miles.

Nearly \$75,000,000 of the \$80,000,000 emergency appropriation had been allotted to projects by May 31; and by August 31, the limiting date set by Congress, virtually the whole amount appropriated had been earned by completion of work. Until the last vouchers are received from the States the exact amount earned can not be ascertained.

Road-Construction Progress

During the fiscal year 1931 Federal-aid projects involving the improvement of 11,033 miles of road were completed. Of this mileage, 7,939 miles were initially improved; that is, the improvements completed were the first to be made with Federal aid on the particular roads involved. Advanced stages of construction, adding a further degree of betterment to roads previously improved to some extent with Federal aid, were completed on 3,082 miles; and 12 miles built a number of years ago with Federal assistance were reconstructed.

The total mileage improved with Federal aid to date and classified as completed, excluding 4,174 miles which was undergoing stage construction or reconstruction at the end of the fiscal year, is 88,713 miles.

Of this completed mileage, nearly 390 miles consisted of bridges over 20 feet in span and their immediate approaches. The remainder of 88,323 miles was made up of roads variously constructed according to the requirements of traffic and the means available in each particular case. Roads totaling 36,626 miles were improved with high-type surfaces of bituminous macadam, bituminous concrete, Portland-cement concrete, and vitrified brick and other block pavements. These are types of improvement suitable for the most heavily traveled roads.

Roads of intermediate traffic density, totaling 4,529 miles, were improved with macadam, various low-cost bituminous mixtures, and bituminous-treated gravel surfaces. On 35,920 miles of less heavily traveled roads, surfaces of gravel without bituminous treatment and sand-clay and topsoil surfaces were laid, and 11,248 miles were improved merely by grading and draining. All of the last class of improvements are approved upon the definite understanding that surfaces adequate to meet traffic requirements will be laid as promptly as possible. The roads thus improved and those on which low-type surfaces have been built are the sections of the system upon which subsequent stage-construction operations will be conducted.

Work in Progress at End of Fiscal Year

At the close of the fiscal year work was in progress on 16,481 miles of road. On 12,306 miles the work under way was the first work to be done with Federal aid; on 4,139 miles the work consisted of an advanced stage of construction added to an improvement previously made with Federal aid; and on 36 miles the work was reconstruction.

The 11,033 miles completed during the fiscal year were built at a total cost of \$255,088,414.09, toward which the Federal Government contributed \$105,918,451.14 and the States the balance. Not all of the Federal contribution to these roads was paid during the past year. Payments were made for work done upon them throughout practically the entire period of their construction, which on many projects considerably exceeded a year.

But the payments actually made to the States during the year on these completed projects and others still under construction exceeded the amount involved in the completed projects and reached the total of \$133,340,910.64. This is the largest sum of Federal-aid money ever paid to the States in a single year. It exceeds by nearly \$12,000,000 the recently increased apportionment of \$121,875,000.

This heavy disbursement, made possible by the existence of a relatively small unexpended balance from previous fiscal years, is another indication of the extent to which the Federal-aid program has been enlarged in the effort to furnish additional employment. So high a rate of expenditure can not be long continued, however, because the expenditures must be kept within the amount apportioned when all accumulated balances have been exhausted.

Forest Highways

In the national forests improvements were completed on 281 miles of the forest-highway system, bringing the total improved to date to 4,638 miles. The forest highways are the most heavily traveled of the roads traversing the forest areas. They comprise a system, which has been designated in cooperation with State highway officials, aggregating

15,024 miles. Of this mileage, 8,787 miles consist of roads which are necessary sections or extensions of the Federal-aid system, and 6,237 miles serve communities within the forests.

For this work also the appropriation authorized for the fiscal year 1931 was increased. For all road work in the forests in 1930 the authorization was \$7,500,000. Of this sum, \$3,000,000 was reserved for the improvement of roads and trails needed for the administration and protection of the forests themselves, and the balance of \$4,500,000 was available for the roads more extensively used by the public. For 1931 the whole authorization was increased to \$12,500,000 and the amount for forest highways to \$9,500,000, the sum reserved for trails remaining \$3,000,000. The act of December 20, 1930, also carried an appropriation of \$3,000,000 to further increase employment on forest-highway work.

As a result of these increased appropriations the forest-highway construction program has been rapidly expanded. The entire amount of the emergency appropriation was obligated by June 30, and there was placed under construction a mileage of projects to be financed with the other available funds exceeding the corresponding mileage in the preceding year by 75 per cent.

The difficulties of location and construction and the short working season entailed by the altitude and isolation of many of the forests have prevented as rapid an expansion of the construction program as was possible in the case of Federal-aid roads; but considering these circumstances, the progress made in this work is very substantial.

NEW CONTACTS WITH FRUIT AND VEGETABLE INDUSTRIES

The passage of the perishable agricultural commodities act, signed June 10, 1930, opened to the department a new field of usefulness to the growers and handlers of fresh fruits and vegetables. This act is designed to suppress unfair and fraudulent practices, to prohibit fraudulent charges, unjustifiable rejections or failures to deliver, and to prevent the discarding or dumping of consigned products without reasonable cause. As a means to this end, handlers of fresh fruits and vegetables moving in interstate or foreign commerce in carload quantities were required to obtain licenses from this department. Violations of the act may be punished by the suspension or revocation of licenses or by publication of the facts. Redress for parties injured by violations of the act may be secured through reparation orders issued by this department after the determination of the facts by investigation and public hearing.

By the close of the fiscal year, 15,180 licenses had been issued. Approximately 1,500 requests were received for the investigation of disputes. Of these, more than 800 were satisfactorily closed. Action by the department's solicitor was invoked in 102 cases; the remainder are pending. Under an earlier enactment, the produce agency act, 296 complaints were received and 217 closed. Thirteen cases went to trial in the United States courts, all of which resulted in convictions.

In the informal handling of many hundreds of cases the department has been able to strengthen the position of that large element in the fruit and vegetable trade which has been striving for many years to improve the business ethics of the industry.

AGRICULTURAL ENGINEERING

Full realization of the possibilities of machinery in agriculture calls for the removal of impediments to machine operation, and in fact for all such modifications of the physical aspects of farms as are necessary to promote economical and scientific management. This is a problem in agricultural engineering. It is being studied, with related problems, by the Bureau of Agricultural Engineering. This bureau, authorized by the last Congress, began its existence on July 1, 1931. It is new, however, only in being a separate bureau. Agricultural engineering work in the department goes back to 1898, when Congress first appropriated money for "irrigation information." Provision was later made for the study of drainage problems. In 1915 the scope of agricultural-engineering research in the department was widened to include a study of farm machinery and farm buildings. Originally the work was divided among different bureaus. In 1925 it was consolidated in the Division of Agricultural Engineering in the Bureau of Public Roads, and reached proportions that suggested the advisability of intrusting it to a distinct bureau.

Sound engineering is indispensable to the economical use of land. This is as true for the small farm as for the large. In fact, the immediate task of the Bureau of Agricultural Engineering is to promote the welfare of our six and a quarter million small-farm operators. It will strive specially to serve the needs of the family farm, particularly in such matters as the construction of farm buildings, the proper choice of farm machinery, the improvement of farm water supplies and farm sanitation, the control of insects and plant diseases by mechanical means, the preservation of farm products by refrigeration, and the prevention of soil erosion. Three problems are outstanding in connection with farm buildings—the need of remodeling farm homes; the improvement of livestock barns, particularly dairy barns; and the provision of more and better farm storage. In connection with farm machinery, considerable work to supplement progress already made is necessary in the mechanical control of the European corn borer and in the more efficient mechanical distribution of fertilizers. Studies in irrigation will be broadened. In irrigation studies the big problem is the conservation of water, rather than the irrigation of additional land. Agricultural engineering may help to prevent soil erosion by developing better terracing methods, and also by indicating desirable changes in machinery designed for use on terraced fields. Improved engineering practices can materially reduce farm costs of production.

ANIMAL-INDUSTRY INVESTIGATIONS

The livestock industry continues to be a valuable balance wheel to agriculture, especially in utilizing crops produced in excess of human requirements. Though low prices have prevailed for food animals this year, stock raising is essentially in a sound and stable condition. Losses from diseases, parasites, and other causes are being steadily reduced, and research dealing with the economy of production is giving new information of public interest and practical value.

Beef-cattle range studies, conducted during the year in cooperation with State experiment stations, showed that materially larger calf crop are obtained from pasture breeding than when the cows are bred on open range or forest reserves. The number of calves alive at weaning

time was from 7 to 11 per cent greater in the case of the pasture-bred lots.

Attention was given to beef-cattle production and meat utilization in southern areas recently released from the cattle-tick quarantine. As a result, increased numbers of cattle were fattened on grain, and the production of higher quality meat rose in many localities. The work resulted in a greater production of feed crops suitable for beef production. Also the number of purebred beef bulls used in the area increased.

Experiments in lamb production again demonstrated the advantage of giving ewes extra feed at breeding time, a practice known as flushing. For this purpose good pasture proved superior to all other feeds. Ewes flushed on extra-good pasture produced 164 lambs per hundred ewes. Those fed grain produced 152 lambs per hundred ewes. Those not given any extra feed at breeding time produced only 143 lambs per hundred ewes.

It has long been customary to feed market hogs all they will eat, to bring them to desired market weights as quickly as possible. In recent investigations, however, limited feeding resulted in more economical pork production. Hogs fed a limited ration made less rapid gains, and required longer feeding periods. But they were more efficient in utilizing their ration and required much less feed per hundred pounds of gain than did those fed a full ration. Moreover, limited feeding produced somewhat leaner carcasses, an advantage since the taste of the American consumer is gradually turning toward leaner pork. These results offer the producer additional means of reducing pork-production costs when market conditions are favorable to a longer feeding period.

Swine-breeding investigations showed, contrary to the general opinion, that crossbreds are not always superior to purebreds in vigor and gains. It was found also that fertility and low mortality were more important factors in economical swine production than minor differences in type and rate of gain.

Meat investigations, conducted by 3 department bureaus cooperatively with 22 experiment stations, continued to throw new light on the factors which make meat tender, palatable, and otherwise desirable from the consumers' standpoint. These results suggested carefully planned performance studies, which were begun during the year, to identify and improve superior strains of meat animals within a breed. Consideration is being given not only to production efficiency, but to carcass yields and quality of meat produced.

Much attention was given to means of increasing the hatchability of hens' eggs. The results obtained were superior to those of previous years, in part because the breeding stock had been selected on the basis of hatchability. A study of the effect of egg production on hatchability showed that a large production of eggs during the breeding season is apparently conducive to good hatchability.

Bovine-Tuberculosis Eradication

The extensive Federal-State task of eradicating tuberculosis from livestock is steadily progressing. The degree of infection among cattle was more than 4 per cent at the beginning of the campaign 13 years ago. The corresponding figure for 1931 was only 1.5 per cent. More than 13,000,000 cattle were tested during the last fiscal year, out of which number 203,778 proved to be tuberculous as indicated by their

reaction to the tuberculin test. The elimination of these animals removed a menace to the public and to the livestock industry.

The method of area testing by which all the cattle in a given unit, generally a county, are tested within a short time again proved effective and economical. At the end of the fiscal year 1,223 counties (and 50 towns in Vermont) had completed one or more tests of all cattle within their borders, and had been officially designated as modified accredited areas. This term signified that bovine tuberculosis has been reduced to one-half of 1 per cent or less and that all reacting cattle have been removed. Four entire States—North Carolina, Maine, Michigan, and Indiana—have been freed of bovine tuberculosis by the area method.

Records of Federal meat inspection indicated further reduction in the number of cattle and hogs condemned as unfit for food because of tuberculosis. This reduction reflected important savings to livestock producers through reduced infection on farms. The benefit will continue, provided owners cooperate with livestock sanitary authorities in preventing reinfection.

The present time is opportune for tuberculosis-eradication work even in highly infected areas. Dairy cattle can be obtained at moderate cost for replacement purposes. Hence the removal of reactors from herds is cheaper than during times of higher prices for cattle and cattle products. Moreover, the indemnity paid and the salvage value received reduce the loss to a low figure in proportion to the benefits of having healthy herds. The average combined Federal and State indemnity paid last year was approximately \$65. In addition owners received a salvage value of about \$25 for the average reactor.

The demand for tuberculin testing in most States continued to exceed the facilities for meeting it, and waiting lists were necessary. Sporadic opposition decreased, largely because of a better understanding of the benefits of eradicating bovine tuberculosis. Court decisions favored the continuance of testing where the authority to do the work or the accuracy of the tests had been questioned.

Tuberculosis of Poultry and Swine

The elimination of tuberculosis from poultry and swine also received added attention, and plans were made for active eradication work in the more seriously infected areas. Farmers in some States have received 2 cents a pound less for their poultry because of the presence of the disease in a large number of fowls marketed. Such losses stimulate interest in the eradication work. Hogs are commonly slaughtered so young that tuberculous lesions are rarely extensive. There is nevertheless a heavy loss owing to the condemnation of hog carcasses and parts, and to the special handling that infected hog carcasses must receive in federally inspected slaughtering establishments. Hogs contract tuberculosis from both cattle and poultry. Hence the suppression of the disease in cattle and poultry is essential to its elimination from hogs. Meanwhile, losses can be reduced by methods of feeding and management that protect cattle, hogs, and poultry from sources of infection. The continued cooperation of livestock owners and the public is earnestly being sought to the end that progress in eradicating this disease may be still further hastened.

Animal Parasites Yield to Science

Of 15 Southern States formerly infected with the cattle-fever tick, only 4—Arkansas, Florida, Louisiana, and Texas—still have quarantined areas. Instead of constituting one solid block, as formerly, the tick-infested region has now been split up into three separate parts bounded by free areas in which sentiment is favorable for an early completion of the entire eradication program.

The department is combating other parasites that hamper stock raising. On the Pacific coast liver-fluke control work, begun on a small scale three years ago, has been extended in California and introduced into sections of Oregon, Nevada, and Arizona. Before the work began ranchers in California suffered severe losses, and sheep raising practically ceased in several areas. Demonstrations by department workers encouraged stock owners to use the system advised for controlling liver-fluke disease, which consists in the destruction of snails on pastures by the application of copper sulphate, and the medicinal treatment of affected animals. Losses were rapidly checked. Where the recommendations were strictly followed, the disease disappeared. Sheep raising was made a dependable enterprise, and sheep a stable security for bank loans. Liver-fluke control has resulted also in material savings in feed and in a more economical production of lambs.

In the Middle West the department's system of preventing the infestation of hogs with roundworms and other parasites has been widely used. Reports show that success in producing hogs varies almost directly with the degree of attention given to sanitation. The cost of swine production was reduced in some instances by approximately one-third.

The program of combating parasitic diseases in livestock and poultry is directed largely along two lines: Research on the life cycles of parasites as a basis for control and preventive measures, and the investigations of remedies. These investigations have revealed essential facts concerning numerous other important parasites, such as kidney worms, nodular worms, and lungworms of swine, and various species of roundworms and tapeworms of poultry. Practically all the remedies used for combating the external and internal parasites of livestock in the United States and abroad have been either discovered or standardized by investigators in this department.

Livestock Regulatory Work Constructive

Though certain forms of Federal regulation are accepted by producers and the public as a necessary protection, a better understanding of this branch of the department's work is highly desirable. Greater knowledge of it should help to prevent both inadvertent and wilful violations. Compliance, in turn, increases the effectiveness of the work which has proved to be highly constructive in its effect on the industry.

In administering the packers and stockyards act, the Secretary of Agriculture has supervision over various practices and conditions, including commission rates and yardage charges. When investigation indicates such marketing costs to be unreasonable, he may order changes. Recent department orders, affecting yardage charges at two markets and commission rates at a third, are estimated to save shippers approximately \$345,000 a year. The settlement of disputes and complaints regarding the quality and weight of feed, alleged shortages, and

the "switching" of animals receive attention. The testing and maintenance of scales for weighing livestock at designated markets are under supervision, and many improvements in the installation of scales have been made. At the close of the year 91 stockyards were "posted" as coming within the jurisdiction of the packers and stockyards act.

Federal meat inspection has increased public confidence in the wholesomeness of meats bearing the Federal stamp of approval. This hygienic service covers the slaughter, and conversion into meat, of about 74,000,000 animals annually. It also helps in the development of a foreign market which, in the absence of inspection, would be largely closed to meat from the United States. During the last fiscal year, 66,436 official meat-inspection certificates were issued, to cover the exportation of more than 900,000,000 pounds of meat and meat-food products. Approximately 33,000,000 pounds of meat and meat-food products offered for importation from foreign countries was inspected. Approximately 300,000 pounds, principally beef, was condemned or refused entry.

Establishments that produce vaccines, serums, and other veterinary products are licensed and inspected. The use of such products, among which anti-hog-cholera serum is the most familiar, enables stockmen to raise a greater proportion of their animals to maturity or market size. The production of clear anti-hog-cholera serum last year increased 19 per cent over that of the preceding year, the total production of all anti-hog-cholera serum increasing less than 5 per cent.

Livestock are admitted into the United States only from countries free from important livestock maladies, and then only in accordance with a system of certificates, inspection, and other means of control. Similar restrictions apply to many products such as hay, other feeding materials, hides, skins, and other articles associated with livestock. Animals shipped in interstate commerce are likewise subject to inspection, dipping, immunizing treatment, and similar safeguards. The results of the year's work show the far-reaching scope of this protection. No serious foreign livestock diseases gained entrance to the United States, though more than 116,000 animals and vast quantities of products associated with livestock were imported. Several hundred animals were refused entry because of diseased or parasitic condition.

Supervision over the movement of livestock in interstate commerce included about 75,000,000 cattle, sheep, and swine of which more than a million were dipped, immunized, or otherwise treated to prevent the spread of disease in areas to which the stock were shipped. More than 22,000 stock cars were cleaned and disinfected under Federal supervision. Similar treatment was given to about 13,500 cars used in the transportation of live poultry.

DAIRY RESEARCH AND SERVICE

Results of 13 years of dairy-cattle breeding research and experimental work enable the department to declare that the most certain way to develop herds with an inheritance for uniformly high production is through the continuous use of "proved sires." A meritorious proved sire is one that has demonstrated through the production records of his daughters that he transmits only a high level of production. Since a bull can not be proved without an adequate number of records of his

daughters, every effort is being made to increase facilities for obtaining and compiling such records. One of the most practical ways is through dairy-herd improvement associations. With the records obtained through these associations, good bulls can be located.

Progressive breeders, agricultural colleges, and experiment stations are proving out a few bulls each year, through the records of their own herds or by lending promising young bulls to cooperators. The Bureau of Dairy Industry compiled this year enough production records on the daughters of bulls it had placed from its experimental herds with cooperators to afford evidence of the transmitting ability of seven Holstein sires. The daughters of six of these sires produced more milk and butterfat than their dams. The increases in milk production ranged from 208 to 2,120 pounds a year, and in butterfat production from 29 to 89 pounds a year. Only one of the seven had daughters which produced less than their dams. Records of eight Jersey sires showed that the daughters of seven of them averaged from 6 to 109 pounds more butterfat production than the dams of the daughters. On the other hand, the daughters of one sire had on an average a yearly production of 21 pounds of butterfat less than their dams. Results of the proved-sire method in herds at various field stations promise success from the application of this principle of breeding, whether the system used be outbreeding, line-breeding, or inbreeding.

Methods of Manufacturing By-Products

The department further developed improved methods of manufacturing cheese, ice cream, casein, and other by-products of the dairy industry and induced many commercial plants to adopt these methods. Half of the 36,000,000 pounds of Swiss cheese consumed annually in the United States is imported. Much of the domestic market is lost to our own dairy industry because American Swiss cheese is frequently not equal in quality to the imported article. It was demonstrated some years ago that the quality of Swiss cheese depends largely on the quality of the milk used in making it, and on the control of bacterial development in the cheese during its manufacture and ripening. The "culture method" of making Swiss cheese, which was developed by the department, enabled factories to produce a higher percentage of high-quality cheese.

Recent improvements in this method promise still better results. The earlier work demonstrated that there are at least two kinds of bacteria essential to proper ripening of this type of cheese and that the quality can usually be improved by adding them to the milk in pure cultures. It was afterward found that a third starter organism is also necessary. Later investigations indicated that the most advantageous rate of growth of these bacteria, their proper numerical relation at the different stages of manufacture and ripening, and the effect of one group on another.

It was found, for example, that certain bacteria are essential to proper eye and flavor development, but that too many cause "over-setting." The rate of growth of this culture was determined under different temperature conditions, and methods of starter making were standardized to introduce a uniform number of eye-forming bacteria into each cheese.

In the last year more than 3,000 packages of bacteria cultures were distributed to cheese factories. Because it is difficult to get these liquid cultures to the factories at just the right time, the bureau developed a dry culture of the eye-forming bacteria. In this culture powder is standardized so that the required number of bacteria for a single cheese can be put in one package, and a supply sufficient for two or three weeks furnished each factory.

Many cheese factories in Ohio, New York, and Wisconsin, including a number which had never before used pure cultures, cooperated in a campaign to introduce the new method into commercial production. Factories using this method have been able to control manufacturing conditions and to produce more uniformly high-grade cheese. Domestic Swiss cheese made by the culture method won first honors last year at the Ohio State Fair, at the Dairy Industries Exposition, and at the Ohio Swiss Cheese Convention.

A method of ripening Cheddar-cheese curd in the container in which the cheese is marketed has been brought to a point at which it may be commercially utilized. The curd, pressed and cut to size, is placed in a specially constructed container wherein it ripens normally without molding. There is no loss of moisture, and hence no rind is formed. The cost of canning is not excessive, and is partly offset by the elimination of shrinkage and paraffining. The department helped factories in 13 States in the South and Middle West in making Cheddar cheese. In the South, where cheese making is a comparatively new industry, specialists recommended changes in methods. As a result, many factories are turning out No. 1 quality cheese. At one factory the sales value of cheese produced increased at the rate of \$4,000 a year.

A method of making uniformly high-quality cottage cheese was demonstrated. This product is known as the low-acid rennet type of cottage cheese. When made properly it has a rich creamy appearance, low acidity, good keeping qualities, and palatability. Cottage cheese is one of the most profitable outlets for by-product skim milk at dairy manufacturing plants, especially when it is of good quality.

Increased Interest in Casein

Increased tariff protection on casein has renewed the interest of domestic creameries in this product, and manufacturers sought aid in applying the new grain-curd method. Five plants in the East and one in the West adopted the method, which enables them better to meet the requirements of the paper-coating industry, the largest consumer of casein. Many western plants manufacture lactic-acid casein. Accordingly, the department this year developed a modification of the grain-curd method which can be used by any casein factory without additional equipment. If all the casein heretofore imported were to be made in this country, it would afford an outlet for about a billion pounds of skim milk annually.

By planning and taking part in educational programs, by sponsoring students' judging contests, and by giving assistance in the training of dairy inspectors, the department aided cities and communities in improving the quality of their milk supplies. Many producers followed suggestions offered to improve the quality of their milk. The program was also forwarded through 4-H dairy clubs, by milk-improvement campaigns on an area basis, and through cooperation with the Federal Board of Vocational Education.

Demonstrations and lectures on improving the quality of milk were presented at the three Rosenwald negro extension schools at Orangeburg, S. C., Prairie View, Tex., and at Nashville, Tenn., before 303 negro extension workers. A resurvey of an important milk-supply area in Maine, where a milk-quality campaign had been conducted the previous year, showed marked improvement in the quality of the milk coming into shipping stations; 57 per cent of the patrons delivered grade 1 milk after the educational campaign, whereas in the year previous the percentage had been only 39.8. Conferences between officers of the United States Public Health Service and department specialists resulted in an agreement to promulgate a milk ordinance embodying recommendations of the two organizations, to serve as a guide to States, municipalities, and communities, in the sanitary regulation of local milk supplies.

PLANT INDUSTRY DEVELOPMENTS

Scientific discoveries and methods of cultivation that reduce costs of production on the farm have perhaps more value in periods of agricultural depression than at any other time. They are a sure means of increasing profits or, at any rate, of reducing losses. More efficient production need not be production in greater volume. Research that leads to increased yields per acre, to increased production of meat and milk per unit of feed consumed, or to improvements in the quality of farm products, though not the sole thing necessary to a profitable agriculture, is nevertheless indispensable.

Some notable contributions were made by the Bureau of Plant Industry to farm technology. This unit in the department has developed and promoted the use of better crop varieties, effected improvements in plant-disease control, and cooperated successfully with other agencies, public and private, in devising means for reducing spoilage in the transportation and storage of farm products.

Improved Varieties of Cotton

Special attention was given to the production of better qualities of cotton. Plant-breeding studies and variety tests have demonstrated that improved varieties which produce longer and more uniform fibers outyield the shorter staple varieties in some localities. These results indicate that the shorter staple varieties in the United States, which produce cotton that comes into direct competition in foreign markets with the short-staple cotton of India and China, could be replaced by longer staple varieties throughout much of the Cotton Belt with little or no sacrifice in yields. Accordingly the department is conducting an educational campaign to encourage the planting of the improved varieties that plant science has developed. It is emphasizing the need for larger quantities of strong and uniform fibers in the automobile industry and in the production of airplanes, balloons, dirigibles, and parachutes. It is stressing also the increasing demand for fine cotton fabrics in clothing. As a first step for regional improvement in cotton production, the need of "single-variety" cotton communities is being urged. This recommendation rests on the necessity for adequate supplies of select seed year after year. Seed can not be maintained varietally pure unless steps are taken to prevent its admixture with other varieties through cross-pollination in the field, as well as through the mixing of the seed in the cotton gin. A means of keeping the seed stock pure is to limit the production in each community to one variety.

New Varieties of Vegetables

Exceptionally good results were obtained in tests of new tomato variety, Break O' Day, which was developed by the department. This tomato is both early and wilt resistant. Break O' Day seed was released in some quantity to a large number of seedsmen all over the country. Except under conditions of abnormally high temperature, it has given unusually good results. The new tomato was received with as much enthusiasm as was the Marglobe tomato some years ago. It is nearly as early as the Earliana variety. It has a large globular red fruit somewhat similar to that of the Marglobe and yields well over a long period. These characteristics, with its resistance to wilt, make it perhaps the most important variety of early tomato introduced since the Earliana.

The department also released for extensive cooperative tests a potato variety called the "Katahdin." This variety is the result of many years of critical hybridization and selection in different potato regions of the United States. It was selected particularly for its resistance to mild mosaic disease. Among other good qualities it has unusual uniformity in the size and shape of the tubers and in their cooking qualities. It is high yielding, comparing favorably in this respect with Rural New Yorker and Green Mountain. It originated in 1923 as the result of a cross made in potato-breeding work. After six years of preliminary testing in Maine it was tested on a small scale in 1930 by a number of growers in widely separated sections of the country and seemed well adapted to muck and peat soils, but not to regions that have summer droughts.

Disease-Resistant Sugar Beets

Important results were recorded in the development of sugar beets resistant to the curly-top disease, which has caused heavy losses in the Western and Intermountain States. Disease-resistant strains have been developed by selection from commercial strains, and by crossing commercial beets with the wild beet of the Mediterranean area. Resistant-hybrid beets thus developed, when planted under moderately severe curly-top conditions, outyielded fields planted with commercial beet seed in the ratio of 3 to 1. They gave satisfactory yields, except under the most severe curly-top conditions. In one of the areas most seriously attacked by the curly-top disease a resistant strain provisionally called "Factory No. 1" outyielded a commercial strain by 4.3 tons of beets and 1,195 pounds of sugar per acre. In several places an increase of seed was obtained from this outstanding strain. Seed stocks from beets resistant to curly top are being increased as rapidly as possible, so that these improved strains may be introduced into commercial use.

Study of orchard-spraying problems resulted in slight, though important, modifications of technic in the handling of spraying materials under different conditions. Valuable information was obtained as to the handling of spray materials on different plant varieties and under different weather and cultural conditions. Considerable experimentation was done with new spraying materials. A public-service patent was taken out on a zinc-lime spray which is used to control bacterial leaf spot on peach foliage. This spray controls leaf spot without injury

to the leaf; in fact it seems to stimulate the foliage. It was used with arsenate of lead in two applications without doing any harm to the trees, and was also used without causing damage in combination with colloidal sulphur and arsenate of lead. Trees sprayed a dozen times, with the recommended strength of this spray, with two of the applications containing arsenate of lead, were not only uninjured but at the end of the season were the best-looking trees in the orchard in which the tests were made.

Control of Plant Diseases

Investigations completed late in 1930 showed threatening developments in the white-pine blister rust situation. A rapid and devastating spread of this disease was discovered in the commercial areas of western white pine in northern Idaho and in adjacent portions of Washington and Montana. White-pine stands over extensive areas will suffer maximum damage by the rust during the next 10 or 15 years unless the disease is controlled. Control is possible only by the systematic eradication or suppression, in or near pine stands, of currant and gooseberry plants (*Ribes*). This is a more difficult and costly task in the Western than in the Eastern States. Many of the pine areas are difficult to reach with labor and supplies; wild currant and gooseberry bushes are abundant; control measures must be concentrated within a short period each season; and mixed ownership of large tracts of wild lands makes control operations difficult. Control is nevertheless possible, provided effective methods are systematically applied on an adequate scale.

Distinct progress has been made in the control of stem rust of wheat through barberry eradication since 1918, when this campaign was started. In the 5-year period 1916-1920 the average annual loss to wheat caused by this rust, aside from its effect on the quality of the grain, was estimated at 57,000,000 bushels. In the 5-year period 1926-1930 the loss attributed to this disease was estimated at less than 10,000,000 bushels. In the interim millions of barberry bushes were destroyed. All told, more than 18,000,000 barberry bushes susceptible to rust have been destroyed in the 13 States of Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. Recent research has indicated that different strains of stem rust, when growing on the leaves of the common barberry, may actually cross and produce new strains which may infect grain bred for resistance to the parent rust forms. Hence the barberry bush, besides carrying considerable quantities of stem rust over the winter in the spring-wheat areas, may also serve as a special breeding ground for new and dangerous forms of the disease.

Refrigeration of Perishables

For a number of years experimental studies have been made on the reaction of perishable fruits and vegetables to the temperature and other environmental conditions encountered during transportation and storage. The primary object has been to improve existing handling practices with a view to increasing the shipping radius and lengthening the period during which the products may be distributed to consumers in sound, wholesome, and attractive condition, with minimum risk of deterioration and at minimum cost.

Experiments made in cooperation with growers' organizations and transportation companies have developed a new method of refrigerating railway cars containing citrus fruits. So that growers may take advantage of this innovation the carriers agreed to an amendment, effective July 20, 1931, of the national perishable protective tariff.

As a result shippers of oranges can obtain adequate refrigeration service at a considerable reduction in cost. On through shipments from California to points on the Atlantic coast the saving may exceed \$30 a car.

The new method simply requires a "preicing" of the refrigerator car some hours before fruit is loaded into it. The fruit cools rapidly after being loaded, and less ice is required to keep it cool in transit. In some of the experimental transcontinental shipments only one transit reicing was necessary. In general, effective refrigeration during hot weather was obtained by a limited icing service, in which cars were reiced at three stations on the transcontinental trip. Much more frequent reicing and the use of considerably greater quantities of ice are prescribed by the old standard method.

Research into this specific problem was started in October, 1928, at the request of the California Citrus League, which believed that the refrigeration methods commonly employed on citrus fruits were unnecessarily expensive and wasteful of ice. The work involved the experimental icing and careful observation of the loading of more than 200 refrigerator cars moving over the principal routes at different seasons of the year.

It was found that in general the most satisfactory and the most economical refrigeration of oranges can be effected by preicing refrigerator cars from 12 to 18 hours before they are loaded. This practice, with limited reicing at selected points in transit, maintained temperatures comparing favorably with those in check shipments handled by the standard method—that is to say, without preicing but with frequent reicing in transit. Repeated tests during high summer temperatures proved the new method to be as satisfactory as the standard method of reicing at 9 to 11 separate stations for shipments en route from California to markets as distant as New York and Boston. At the reduced icing charges made available under the revised freight tariff already mentioned the limited-icing method effects important savings on direct shipments to eastern auctions and also on general shipments precooled and preiced by the shippers.

INSECT-PEST CONDITIONS

The 1930 drought was for the most part favorable to insect multiplication. It reduced disease among insects and aided their hibernation. As a result infestations this year were generally heavy. Notable exceptions occurred, however, including such important crop pests as the European corn borer, the Mexican bean beetle, the oriental fruit moth, and the plum curculio. Except in the case of the curculio, reductions in the number of these pests resulted chiefly from the wilting of leaves, which exposed eggs and young larvae to the sun, and from unfavorable food conditions. The plum curculio was greatly checked by the drying and baking of soil entered by the larvae. Surveys and field counts made in the fall of 1930 indicated that the European corn borer was reduced in numbers from 20 per cent in Michigan to about 60 per

cent in Ohio. It was much reduced also in Pennsylvania and Indiana. There was no important commercial damage from this insect. The Mexican bean beetle was reduced so much that control work was unnecessary in most sections. The plum curculio and the oriental fruit moth did very little commercial damage.

Exceptional grasshopper outbreaks were the most striking examples of increased damage. Heavy chinch-bug injury characteristically and normally follows drought conditions. It did so last year and again this year. The chinch bug is checked by humid conditions, which subject it to the attacks of a parasitic fungus. Codling-moth injury to apples and pears, which was greatly increased by the drought of 1930, extended into the present season. The infestation was the highest on record.

The summer of 1930 was favorable also to the common cattle grubs, *Hypoderma* species, and serious infestations were reported in 1931 from areas in the Red River Valley of the North, where previously these pests had been little known. Last year's drought also contributed to an exceptional outbreak of buffalo gnats, with resulting heavy injury to livestock in the lower Mississippi Valley. Normally such outbreaks follow unusual rainfall and floods, which enable these biting gnats to breed on submerged vegetation. In this instance the lowering of water levels resulted in a growth of vegetation on exposed stream borders and beds. This vegetation, when flooded by the return of normal rains, furnished favorable breeding conditions.

The southern pine beetle, one of the most destructive forest pests of the Appalachian regions, is favored by moisture deficiency. Losses caused by this insect in the 1930-31 season exceeded any experienced since 1910-11.

Grasshopper Outbreaks

The most notable insect damage of the year resulted from an unprecedented increase of certain grasshoppers which are always present throughout the Mississippi Valley States. The insects chiefly concerned are the 2-striped grasshopper and the differential grasshopper. Both are rather heavy-bodied species, and not migratory except in local movements. The differential grasshopper is a fairly strong flyer and under exceptional conditions may move a little more widely; but there are no records of its ever having been observed migrating in the true sense, that is in large swarms to distant areas. Hence this year's grasshopper damage has no relationship to the historic ravages by the Rocky Mountain locust in the seventies and eighties of the last century. The Rocky Mountain locust could fly hundreds of miles. It seems to have practically disappeared from the western plains, where it formerly occurred in myriads.

The situation this year was an outcome of two or three years favorable to local grasshopper multiplication and unfavorable to the fungous diseases and other natural control agencies that normally check increase. Furthermore, the winter of 1930-31 was exceptionally favorable to grasshopper survival, as were also the spring and early summer conditions of 1931. These conditions prevailed generally throughout the United States, from Texas northward to Canada and also east of the Mississippi. The heaviest damage occurred in the central part of South Dakota and the contiguous section in northern Nebraska.

Heavy grasshopper outbreaks in 1931 were predicted by Federal entomologists, and the need of preparation to fight the insects was

emphasized. Adequate steps, however, were not taken. Effective controls are possible chiefly against the "egg beds" and against the newly hatched hoppers. After the insects have reached practically full growth and are becoming winged, control becomes difficult or impracticable. The eggs can be destroyed by cultivating areas where the grasshoppers have collected for oviposition. The young insects can be controlled even more effectively by the use of poisoned bran baits as they emerge from egg-laying areas, or during their migration to small-grain and forage fields and later to corn.

The damage, though exaggerated in many reports, was so serious in its worst phases as to arouse general interest, and many demands were received for Federal aid for the poisoning of these hungry hordes of insects which threatened the destruction of thousands of acres of crops in the Great Plains area of the west. Unfortunately the department had no funds available for the purchase of poisons or for labor. All that could be done was to cooperate with State and local agencies in directing practicable control measures.

Abundance of hoppers and prospective damage were indicated early in May when hatching began over the areas of egg deposition, in some of which the eggs had been placed in the sod at the rate of 10,000 to the square foot. Over most of the area, before any important action was taken by the States concerned, the most effective period for control had passed. Some benefit would still have been possible had an adequate supply of poisoned bait, and means for its application, been available. In South Dakota, where operations were begun early in June, the commercial bait mixture used—24 carloads of which were distributed—contained poison at only half the required rate. The use of this bait was naturally disappointing. Toward the end of June a much better bait, prepared commercially under the proper formula, became available and gave excellent results. By this time, however, the movement of grasshoppers from small-grain and forage crops was well under way and many fields of corn had been destroyed. The distribution of poisoned bait at this time killed the insects that fed on it, but the enormous number of grasshoppers that continued to move into corn made it impossible to save the crops. It soon became evident that further large-scale poisoning for the season was a wasted effort, and a general determination was reached to conserve the funds made available by the States for use in the destruction of eggs in the winter of 1931-32, and particularly for the baiting of the young grasshoppers of next year's brood.

The outlook for 1932 can not now be definitely indicated. The situation may be more or less safeguarded by winter and spring conditions adverse to the insects. It seems desirable, however, to make preparations to prevent a repetition of this year's experience. This department will help to survey localities in which egg masses are likely to be deposited in large numbers, and to supervise the destruction of grasshopper eggs during the winter by cultivation. It will cooperate also in the more important work of poisoning the young hoppers early next season.

Mexican Bean Beetle

The Mexican bean beetle has now spread from the Southwestern States, where it has long been established, through the Southern, Central, and Eastern States and as far north as Canada, and continues to be the most important pest of the bean crop. Public interest in this

insect is greatly accentuated by the fact that it has made the kitchen-garden culture of beans as a table vegetable very uncertain. While the control of the bean beetle in commercial plantings for the market or for canning is readily obtained by three or four applications of magnesium arsenate, applied with adequate machinery and at the proper time as a spray, the similar control of the pest on garden crops is much more difficult. Not only is it difficult to have such spraying done as efficiently as to method and time, but more treatments are needed, because in such garden cultures the picking is extended over the longest possible period, whereas in commercial cultures it concerns usually only a few pickings over a much shorter period. Control is also possible with pyrethrum extracts. These materials are particularly useful on small garden plantings when it is necessary to apply a remedy after the crop has reached the bearing stage, since pyrethrum is nonpoisonous to man in the dilutions used to control the beetle.

The effect on the bean beetle of the long drought and high temperatures of 1930 was to reduce the winter carry-over of this pest. Damage from it during the current season was much reduced. No permanent natural control of the bean beetle by parasites has been developed in this country. Attempts have been made to introduce a parasite from Mexico, but it has proved difficult to carry the insect over the winter. In the winter of 1930-31, however, a large number of parasites were bred in a greenhouse and liberated. The establishment of this beneficial insect should help to reduce the bean-beetle menace.

Japanese Beetle

The Japanese beetle is becoming less abundant in the sections reached first in its spread from where it was introduced in New Jersey. This is partly a result of natural controls—diseases and parasitic insects—such as normally come, although often slowly, in the case of most introduced pests. Some of the decrease, however, may be credited to the importation from Asia of foreign parasites of the beetle. This work has established considerable numbers of certain enemies of the beetle and its grub in the invaded area.

Artificial control, through baits and insecticides, is becoming more effective. The beetle, however, is very resistant to poisons, and the grubs must be reached by difficult soil treatments. A new phase of control has been developed this year in the application of a dust to sweet corn at the beginning of the "silking" stage. This protects the silk from attacks of the beetle, and thus safeguards the growing crop. Another recent development has been the successful application of acid-lead arsenate to soil in nursey plantings and to lawns for the destruction of the grubs—a required condition in the shipment of nursery stock under the Japanese-beetle quarantine.

Mediterranean Fruit Fly

Research work on the Mediterranean fruit fly has been concluded in Florida but is being pushed in Hawaii. In Florida investigations initiated in the eradication effort of 1929 were completed. The results will help in the control of the pest should it again get a foothold in the United States. Important studies deal with the action, harmful or otherwise, of arsenic, copper, and other bait sprays on citrus and other fruit trees, and with the cultivated and wild fruits of Florida which are possible hosts of the fly. A study has been completed also of certain

native fruit flies which occur in Florida. This assembles much information which will facilitate the determination of any suspected maggots in fruit, and their easy separation from the dreaded Mediterranean species. Studies of the insect itself and its control in relation to its various host fruits have been conducted in Hawaii since the end of 1929. The University of Hawaii built specially designed laboratories and offices for the department's workers, and set aside land for experimental plantings. Closely related is a study of the native fruit flies of Mexico, in which the Mexican Department of Agriculture cooperated.

A New Pest of Stored Tobacco

A serious type of insect injury to stored leaf tobacco developed during the year. It was caused by the larvae of a cosmopolitan moth, *Ephestia elutella*, which hitherto has not been at all abundant or even destructive in the United States, and in this and other countries has confined itself largely to stored vegetable foods. In such associations it has been several times reported in the United States. Early in August, 1930, it was found to be heavily infesting stored leaf tobacco in an isolated area in the bright-tobacco belt. Thousands of moths were flying about in the warehouses, and the feeding of the larvae had extended 3 or 4 inches into the tobacco as stored in hogsheads.

Following the report of this injury, a thorough investigation was made which indicated that the infestation was confined to five warehouses. Some 31,000,000 pounds of leaf tobacco valued at \$10,500,000 were involved, infestation being heaviest in the more valuable grades. The warehouses containing this tobacco were given drastic fumigation in August of last year and a second and even heavier fumigation in June of this year. These fumigations largely eliminated the pest. The moth must, however, be reckoned with as a future potential pest of leaf tobacco.

Arsenic-Residue Problem

In the last 50 years various arsenical insecticides have become standard for the control of many fruit and vegetable pests. A result is the arsenic-residue problem, the urgency of which increases with the wider use of arsenicals, and with the enforcement of restrictions as to arsenic tolerance in products both for domestic use and for export. In fruits this situation is met by washing them either in diluted acid or alkali, but the problem can not be considered solved until a remedy is found that will control the codling moth, the Mexican bean beetle, and similar pests, and will not leave an objectionable residue.

In the case of the codling moth, hope is now seen in certain fluorine compounds. Two—barium fluosilicate and cryolite—gave satisfactory results in field tests conducted in the Pacific Northwest in 1930 and again this year. These compounds and others have proved inadequate for the control of the codling moth in humid sections, but the results obtained in comparatively dry regions suggest the possibility of adapting them to other climates. Another alternative for arsenicals is the use of a mixture of nicotine sulphate in a dilute white-oil emulsion—a combination which has given fairly good results when used against the apple worm in the Northwest, but has again been less satisfactory elsewhere.

Black Fly

This department and the Cuban Department of Agriculture completed this year a cooperative project looking to the control of the black fly, a pest attacking the leaves of trees and not the fruit. It is the most important enemy of citrus trees in Cuba and other islands of the West Indies and in Central America. The risk to the Florida citrus crop is obvious. The original home of the black fly was believed to be in southeastern Asia, and it was known that natural parasites of this pest occurred there which, if imported, might accomplish effective control. The Cuban authorities offered to make this attempt and to assume the operating costs of the undertaking if the department would supply technical personnel. This was done with notable success. Several different types of minute wasp parasites were introduced. One of these, *Eretmocerus serius*, multiplied to an extent that permitted liberations throughout Cuba, and also the establishment of colonies in the Canal Zone and Haiti. For Cuba the black-fly menace is now looked upon as fully controlled. All groves in which colonies of the parasites were established prior to October, 1930, are now commercially free from the fly. A number of coccinellid beetles were also introduced. One of these has proved able to do effective work, though not with the certainty of the parasite *Eretmocerus serius*. A sympathetic attitude toward the collection and importation of insect parasites has developed throughout the world. The United States has benefited, and has extended benefits to other countries. For example, the department this year, in response to a request from the Government of Spain, transmitted to that country a considerable shipment of an important parasite of the Mediterranean fruit fly, long since established in Hawaii but not occurring in Spain. This shipment reached its destination and is being successfully propagated there.

PLANT QUARANTINES

The work of the department in the eradication of the Mediterranean fruit fly in Florida was so successful that on November 15, 1930, all the restrictions on the movement of Florida products on account of this insect were removed. The last infestation was found in a doorway in St. Augustine, Fla., on July 25, 1930. Suspension of field inspection was necessitated by lack of funds from March 27, 1930, to June 13, 1930. Funds were made available on the latter date, and inspection was resumed. This work was done by from 220 to 750 inspectors until March 31, 1931, when it was discontinued. The quarantine maintained in Florida from May 1, 1929, to November 15, 1930, prevented the spread of the insect to other States. Moreover, it assured open markets for Florida's products. States receiving these products accepted them with reasonable certainty that their fruit and vegetable industries were not jeopardized.

Similar results attended the enforcement of other quarantines by the department. A notable illustration is the Japanese-beetle quarantine. Products within the infested area are inspected by the department and certificates are issued which, so far as Japanese beetle is concerned, carry the plants to their destination and insure their acceptance. Experiments conducted during the year made it possible to modify the Japanese-beetle quarantine restrictions on products moving out of the

infested area in such a way as to permit greater freedom in shipping them. Nurserymen and others affected cooperated willingly with the department in endeavoring to retard the spread of this insect.

Gipsy-Moth Control Work

Quarantine and eradication work accomplished the apparent extermination of the gipsy moth in a large area in the State of New Jersey. In 1921 more than three million egg clusters were found in an area of approximately 400 square miles. Eradication measures were undertaken in cooperation with the State Department of Agriculture of New Jersey. No gipsy moth, in any stage, has been found in this area since May, 1929.

The gipsy moth has been abundant in New England since 1889. For years its westward spread was gradual but steady. Eight years ago the department, with the cooperation of the New England States and the State of New York, established a barrier zone about 30 miles wide extending from the Canadian line to Long Island Sound. This zone is in the eastern part of New York State and the western parts of Massachusetts, Connecticut, and Vermont. Inspections are made by the department and by the State of New York, and any infestations found are exterminated. So far as is known no infestation has become established west of the barrier zone.

Pink Bollworm of Cotton

The pink bollworm of cotton, which is established only in comparatively small areas in the southwestern section of the United States, constitutes a serious threat. Eradication is undertaken where it seems practicable, and efforts are made in all infested areas toward preventing the spread of the pest to the main cotton-producing regions. The first necessity is the determination of the infested areas. Remarkable progress has been made in this work through the development of machines which separate any pink bollworms which may be present in gin trash. Each machine does the work of many men, and does it better. These machines, supplemented by the gathering and inspection at a central point of representative samples of cotton bolls throughout the Cotton Belt, made possible in the 1930-31 season, for the first time, a fairly comprehensive analysis of insect conditions in the main Cotton Belt. No pink bollworm infestation was discovered in the main cotton-growing areas.

Tests conducted in the fumigation and compression of baled cotton lint permitted the removal of certain fumigation requirements in areas known to be lightly infested by the pink bollworm. This modification of the quarantine saved many thousands of dollars to cotton producers, without increasing the risk of spreading the insect to areas not now infested.

Maintenance of the European corn-borer quarantine prevented this insect from reaching the main corn-producing regions of the United States and afforded more time for perfecting control operations.

Inspection forces at the ports of entry in the United States have been substantially increased. This not only gives better protection against the importation of injurious pests but permits the entry, under proper supervision, of larger numbers of plants which can safely be admitted.

CHEMISTRY AND SOIL RESEARCH

Investigations in the Bureau of Chemistry and Soils brought some significant results in the protection of foods and other farm products against various destructive influences, in the utilization of farm by-products, in soil conservation, and in the adaptation of fertilizers to particular soil requirements. Further progress was made in the development of important new insecticides. Specialists in the bureau cooperated with farmers and manufacturers in developing practical applications for recent chemical discoveries, and also in experiments undertaken to test, on a commercial scale, some of the more promising laboratory results.

Losses from the spontaneous heating of hay are not confined to the burning of barns and other farm property. Damage of this sort, though estimated to exceed \$20,000,000 annually, is multiplied many times by the loss that results from the decrease in weight and nutritive value of hay which occurs during spontaneous heating. This country's hay crop has an estimated average annual value of about \$1,300,000,000. At least a tenth of our harvested grass crop is destroyed by spontaneous heating. Experiments conducted with experimental barns and other equipment have thrown new light on the spontaneous heating and combustion of hay. It is now believed that hay bacteria, in the parts of the haymow from which air is excluded, produce unstable compounds that undergo rapid oxidation when air is accidentally admitted with a development of heat rapid enough under certain conditions to set fire to the hay. If this proves to be the case, an important step will have been taken toward the discovery of practical means of reducing losses from spontaneous heating.

Experiments conducted over a period of eight years resulted recently in proof that leather absorbs sulphurous and sulphuric acids from the gaseous pollutions of the atmosphere. This is one cause and perhaps the primary cause of the relatively rapid rotting and short life of many leather goods, such as harnesses, bookbindings, upholstery, and bags. Paper also, experiments showed, may be damaged by the absorption of gases from the air. Accordingly, research is being directed toward the discovery of types of leather and paper that can withstand this deteriorating influence. Efforts are being made also to develop, for leather, protective dressings or treatments.

Fumigants and Insecticides

In experiments with new fumigants and insecticides extremely promising results were recorded. Ethylene oxide, a fumigant discovered by the department in 1927, is made more effective when mixed with carbon dioxide, and also is free from fire or explosion hazard. This fumigant is used in the fumigation of grain, foodstuffs, and other commodities. Following a hearing before the examiner of interferences of the United States Patent Office, in which the priority of the department in the use of ethylene oxide as a fumigant was upheld against the claims of certain German inventors, a public-service patent for the discovery was issued to two members of the department. Thus the fumigant was made available to all American citizens, and its wide use encouraged.

The department recently developed a synthetic organic compound which is more toxic than nicotine when sprayed upon aphids. Nicotine, one of the most valuable insecticides used by orchardists, truck-

crop growers, nurserymen, and florists, is not available in sufficient supply. The new synthetic substitute is called neonicotine. One of the largest manufacturers of coal-tar products is making an insecticide which contains neonicotine as its active ingredient. A common Russian weed, *Anabasis aphylla*, was recently found to contain as much as 2 per cent neonicotine and related alkaloids. Efforts are being made to introduce the cultivation of this plant into the United States.

Utilization of By-Products

Chemical research is steadily accumulating knowledge useful in the utilization of agricultural by-products. Sugarcane bagasse, a material formerly produced in amounts smaller than those required by the insulation-board industry, is now, as a result of the introduction of mosaic-resistant varieties of sugarcane in Louisiana, produced in excess of the demand. Studies showed methods whereby bagasse may be made a source of cellulose equal to any now available, except that manufactured from cotton linters. Cellulose from bagasse, it is hoped will find an application in the rayon and the nitrocellulose industries. Several new compounds were obtained this year from lignin, a substance present in the straw, stalks, hulls, and other cellular residues of leading crops. Some of these new compounds seem likely to be useful in the pharmaceutical and chemical industries. Lignin has possibilities also in the production of synthetic resins, dyestuffs, and tanning materials.

Means have been developed for the production of fine-quality starch from sweetpotatoes of any variety, regardless of whether or not they have been stored. This discovery has promising economic possibilities, because the percentage of culls in the sweetpotato crop is large. At present cull sweetpotatoes are either wasted or inadequately utilized. In a vegetable crop second in importance only to the potato crop, a cull problem of this magnitude obviously demands a remedy. From 10 to 20 per cent of the sweetpotato crop consists of oversize or undersize sweetpotatoes that must be classed as culls owing to the stringency of market grades. Sweetpotato starch has properties generally similar to those of potato starch, a commodity imported into this country in large amounts.

Industrial uses may be found for the waxy coating of apples. Research recently showed that this coating consists principally of a paraffin hydrocarbon, a solid alcohol, and a hydroxy acid known as ursolic acid. A commercial research laboratory experimented with these materials, and reported that they might be commercially valuable, particularly in retarding the drying and in improving the gloss and water resistance of cellulose lacquers. Crude ursolic acid may find a commercial application as a waterproofing material. The sodium salt of ursolic acid acts as an emulsifier of water in oils. The paraffin hydrocarbon has properties that suggest its use in paint and varnish removers. It has been estimated that nearly half a million pounds of each of the principal constituents above mentioned could be recovered from the residues obtained in the canning of apples, in cider and vinegar making, and in the dehydration of apples. Many commercial firms are seeking industrial uses for these apple-surface compounds.

Research in the department and in the State experiment stations has shown that copper is an essential requirement of plants and animals. Traces of copper added to certain unproductive soils lacking copper

make these soils productive. Anemia in man and in animals may often be corrected by the use of foods containing copper. Experiment station workers discovered that the so-called salt sickness of cattle in certain parts of Florida results from a deficiency of copper in their forage and other foods.

Progress of Soil Surveys

In the last fiscal year the department completed a detailed mapping and description of 28,530 square miles of soils in 30 States and in Porto Rico and the Virgin Islands. In addition it made reconnaissance surveys of 10,014 square miles in Minnesota, Montana, Oklahoma, and Vermont. This work brought the entire area mapped and described since the soil survey was begun to 1,449,792 square miles, or 927,866,880 acres. Knowledge gained in soil surveys is the basis of some important recent agricultural developments. In Georgia, for example, soil surveys located and ascertained the quality of certain soil types adapted to tobacco. Trials were made, the tobacco crops succeeded, and tobacco growing developed within a few years from a comparatively unimportant position to one in which it stands second in value among the crops produced in Georgia. By other soil surveys certain soils in the piedmont section of Georgia were found suited to alfalfa, and this crop is now spreading there rapidly.

Soil studies often indicate profitable fertilizer practice. A good example is the growing practice of applying small amounts of phosphatic fertilizer to sugar beets. This practice, the economy of which was determined by soil specialists in the Bureau of Chemistry and Soils, increases yields about 3 tons of sugar beets per acre, and is widely used throughout the western beet-growing territory. This pioneer work has increased the value of the sugar-beet crop in the western sugar-beet area by \$4,000,000 or \$5,000,000 annually. Beneficial results have likewise followed fertilizer experiments conducted in the principal sugarcane areas of Louisiana. In an important strawberry-growing district of North Carolina, growers formerly used about 1,500 pounds per acre of a well-balanced fertilizer annually. They put this down in two applications, one in late summer after the berries were harvested, and the second in the following winter. Tests showed that yields may be greatly increased by applying all the fertilizer in one application late in the summer or early in the fall. This simple change, in various tests and eventually in commercial practice, produced from 400 to 500 quarts of berries per acre more than the split applications previously used. Furthermore, the berries matured earlier. Strawberry growers in the Chadburn district of North Carolina, by using the new method of applying fertilizer, received this season about \$75 an acre more than they would have received had they used the old method.

Fertilizer Studies Productive

Recent experiments have shown that concentrated fertilizers are often more effective when, in addition to nitrogen, phosphorus, and potash, they contain some or all of the less common essential elements for plant growth. These include calcium, magnesium, manganese, copper, zinc, nickel, and boron. On some soils, synthetic and concentrated fertilizers of the sort commonly sold have a low efficiency, which is too marked to be the result of improper distribution or placement of the fertilizer. The trouble may be a shortage of some rare essential chemical. Manganese was found to be deficient in soils in a large area

in Florida, and in a group of soils on the Atlantic seaboard further north. By supplying this essential element, growers have netted good returns from land that was formerly unprofitable. Extensive areas formerly barren now produce a variety of truck crops for the northern markets.

Chemical research under way has an important bearing on the fertilizer industry. The farmers of the United States in recent years have spent about \$250,000,000 annually for commercial fertilizer. So that they may get more value for this expenditure, the department conducts investigations to learn how nitrogen, phosphoric acid, potash, and other materials may be more effectively converted into fertilizers; how methods of applying fertilizers may be improved; and how sources of fertilizer materials may be developed. This last-mentioned item is particularly important because the United States is still dependent on foreign sources for no less than 80 per cent of the potash used in agriculture. American potash production is increasing, however, and now supplies annually about 100,000 tons of fertilizer salts. An important potash mine, producing water-soluble potash salt, was recently opened in New Mexico. Various potash materials exist in great quantities in various parts of the United States, and the department is studying how these may be commercially developed. Recently published results of research on blast-furnace problems are expected to have a favorable influence on the production of potash and phosphoric acid fertilizer in the United States.

Ammonia in Superphosphates

One of the most interesting recent developments in fertilizer manufacture is the direct use of ammonia in the treatment of superphosphates used in the manufacture of mixed fertilizers. This has certain advantages combined with disadvantages. This ammonia-treated superphosphate in fertilizer mixtures improves their mechanical condition, prevents rotting of the bags, and gives a more highly concentrated fertilizer. On the other hand, the availability of the phosphoric acid is reduced. Accordingly, the proportion of free ammonia which can be used economically in the manufacture of fertilizer mixtures is limited to about one-fourth or one-third of the maximum that could be included. Studies recently showed, however, that the use of free ammonia in fertilizer manufacture should not reduce the availability of the phosphoric acid as much as was supposed. Experiments made in this connection were confirmed at agricultural experiment stations throughout the country. Interest in this problem was so great that more than 25 research institutions participated in the tests, which showed that it should be possible to double the quantity of free ammonia used in manufacturing fertilizer mixtures without appreciably lowering the value of the phosphoric acid. Accordingly, State officials are taking steps which will permit an increase of about 100 per cent in the use of free ammonia in fertilizer manufacture. This will mean an increase of about 80,000 tons per annum in the use of synthetic ammonia. This quantity is worth at wholesale about \$8,000,000. The direct use of ammonia in fertilizer mixtures has the added advantage that it improves their drillability, and promotes a more uniform distribution in the field. Tests at State experiment stations have shown that a uniform distribution of fertilizer gives at least a 10 per cent saving.

Soil-Erosion Problems

Erosion, which annually removes fully 500,000,000 tons of soil from the farms of the United States, is the subject of extensive investigations. Two stations for the experimental study of soil erosion were established during the last year in the States of Washington and Iowa. Six similar stations had been previously set up. These are located in Oklahoma, Kansas, Mississippi, Missouri, Texas, and North Carolina. The new stations are in the Washington-Oregon-Idaho wheat belt and the rich loessial Corn Belt soil area of the Missouri River Valley, in both of which regions erosion is a serious problem. Funds for an erosion-control and moisture-conservation program were appropriated by Congress in 1930.

It was demonstrated during the last year that on certain moderately steep slopes, some soil types erode so rapidly that it seems impossible to utilize the land for clean-tilled crops except by strip farming, with terracing and the use of soil-saving crop rotations as well. These methods, however, promise to be very effective. Subsoiling in alternate strips is also under experimentation. Terracing proved valuable in the rolling parts of the red plains of Oklahoma, not only in slowing down erosion but in partly rehabilitating eroded land. At the erosion station in Missouri, a field badly damaged by sheet erosion and gully-ing was reclaimed by constructing small dams in the gullies. These dams were made with old fertilizer sacks filled with soil and bluegrass roots. The bluegrass roots grew through the bags, took hold of the ground, and established "living" dams, which quickly silted in from above with the first rains. Between the dams the gullies were seeded to wheat, which grew well. This experiment, because of its practicability and cheapness, attracted wide attention. At the Oklahoma station it was found that cotton from eroded land has less strength than cotton from uneroded land, and that the seed contains considerably less oil. The average depth of the topsoil of our uplands is only about 9 inches. In some localities this is being washed off at the rate of 1 inch in from four to eight years. In losing this layer, which contains far more plant food than the unweathered raw subsoil, the farmer is losing his principal capital. Better protection of erosive cultivated areas is a national necessity.

A representative of the department, with the cooperation of a representative of the Kansas Agricultural Experiment Station, has built a cultivator which promises to prove effective as a means of conserving soil and water in that region, and possibly in other regions, by causing more of the rainfall to sink into the ground, thus reducing erosion. This machine can be used both as a cultivator for row crops and as a surface-tillage implement for fallow. It digs approximately 10,000 holes per acre, each hole having a capacity for holding 2 to 3 gallons of rain water. Although the holes collectively impound a large amount of water, their greatest value comes from the fact that the water is held still and given a chance to soak into the ground.

FORESTRY

The forestry work of the department supplements its work for agriculture. Agriculture and forestry apply the same basic sciences to the same basic end of land use. Which is preferable in any given case depends partly upon the physical factors that determine crop productive-

ness, and partly upon economic and social requirements. Continued overproduction of agricultural products has made conspicuous a need to find other ways of making serviceable a vast aggregate of potentially cultivable land. There is also the vast acreage of forest land which has no agricultural possibilities at all. The department seeks to find out how to make forestry a good form of land use and how to utilize the products of the forest to best advantage; it seeks to bring about the application of suitable forestry practices; it administers the national-forest enterprise; and it cooperates with the States for the promotion of forestry under the terms of the Weeks, Clarke-McNary, and amendatory laws.

Forest Improvements

Congress increased the funds for national-forest improvements from \$645,000 for 1930 to \$2,500,000 for 1931. Nearly all of this was for improvements to facilitate fire control, chiefly roads and trails. Additional road and trail funds provided elsewhere in the agricultural appropriation act, in the second deficiency act, 1930, and under the continuing appropriation of 10 per cent of the national-forest receipts exceeded by \$3,545,168 the corresponding amounts for the previous year. A further increase of \$6,354,800 was made in the 1931 appropriations under legislation providing for emergency constructions of various kinds, chiefly road building, and for emergency work in the control of insect infestation. On the other hand, various cuts in appropriations for national-forest purposes other than improvements, and for fire fighting, reduced by more than \$2,000,000 the funds thus made available.

All told, Congress appropriated for national-forest improvements nearly \$20,500,000. In part this was inspired by the policy of the administration and of Congress to increase employment. What was accomplished by the Forest Service in this field is related elsewhere in the present report. The Forest Service happened to be peculiarly prepared to expand construction work along needed and approved lines. It had a carefully worked out long-time improvement program for the national forests, and its organization provided the necessary leadership for immediately inaugurating a large number of local projects.

Fire Protection

To give the forests efficient and economical protection and to bring about full use of their resources necessitates a large investment in roads and trails, lookout houses, cabins and other administrative structures, telephone lines, and many other improvements. As protection is facilitated fire losses are reduced and the heavy costs of suppressing great fires are less frequently entailed. To complete the entire improvement program for the national forests will require a further large outlay; progress must necessarily be adjusted to the financial exigencies of the Government. That the improvements already constructed are proving a sound investment the results obtained in protecting the forests during the severe fire season of 1930 and the current year clearly show. A major advance in solving the extremely difficult problem of fire control in the West can with some confidence be claimed.

The heart of the problem is how to stop fires in bad years. Such years occur irregularly. They are the result of unfavorable weather—

abnormal heat, violent winds, very low atmospheric humidity, and electric storms with heavily "bunched" lightning. Since 1905 the bad years have been 1910, 1919, 1924, 1926, 1929, 1930, and 1931. Recent years have witnessed a cumulative shortage of precipitation that has reduced the supply of ground water and affected vegetation. In most respects 1930 was as bad a year as almost any of its predecessors. But while the area burned over in the preceding five years averaged 0.29 per cent of the entire national-forest area annually, the 1930 fires were held to 0.11 per cent of the entire area.

In 1929 nearly 800,000 acres were burned over; in 1930 less than 140,000 acres. Yet the 8,388 fires in 1930 exceeded by 12.6 per cent the number of those in 1929.

In 1930 the fire-fighting expenditures, exclusive of the time of forest officers, were less than \$1,200,000, as against more than \$3,200,000 in 1929. The fire damage in 1930 was estimated at less than \$350,000; in 1929, at nearly \$4,340,000. The difference was due partly to better preparedness. This was made possible by the larger provision of funds for improvement construction and for fire-fighting equipment. The whole work of suppression has been raised to a new level of efficiency and speed, so that fewer fires attain large size and those which do are held within narrower limits and are much more quickly brought under control.

Extension and Consolidation of National Forests

Sound principles of land economy and public interest seem to dictate both the extension and better consolidation of the national forests by (1) the addition thereto of the remaining public lands most valuable for timber production and stream-flow protection, and (2) the acquisition of privately owned lands within national forests by exchanges therefor of national-forest lands or stumpage in the Western States and by purchase under the Weeks and Clarke-McNary laws in the Eastern States.

A recent study shows that of the remaining unreserved and unappropriated public lands in the Western States some 19,000,000 acres are of such importance for timber production or stream-flow protection as to suggest that the addition to the national forests of a considerable part thereof would be in the public interest.

More than half of the State and private lands within national-forest boundaries in the Western States and several million acres of similar lands outside but contiguous to the national forests are integral with the public properties. The acquisition of such lands through exchanges to the possible extent of some 15,000,000 acres or more demands eventual consideration. Many opportunities for land exchanges advantageous to the United States are now available, but can be approved only where they do not involve any appreciable reduction in timber-sale receipts or the proportion thereof payable to the counties.

To date Congress has enacted a total of 66 laws authorizing the Secretary of Agriculture, with the concurrence of the Secretary of the Interior, to exchange national-forest lands or stumpage for privately owned lands within or contiguous to national forests where such exchanges will consolidate and improve the public properties. The net result of these 66 acts, as of December 31, 1930, has been the consummation of 691 exchange cases whereby the United States has acquired

1,005,527 acres of land valued at \$4,119,155 in exchange for 291,697 acres of national-forest land valued at \$1,538,278 and 768,563,000 board feet of national-forest stumpage valued at \$2,096,789. Besides the net gain of 713,830 acres in national-forest area, the volume of stumpage on the acquired lands is greater than that surrendered. During the year, 157 new land-exchange cases were approved and submitted to the Secretary of the Interior. These contemplate the conveyance to the United States of 304,906 acres of privately owned lands in exchange for 30,890 acres of national-forest land and \$570,844 worth of national-forest stumpage.

East of the Great Plains the national-forest lands now comprise 2,482,746 acres reserved from the public lands and 4,675,020 acres acquired by or in process of purchase under the Weeks and Clarke-McNary laws. The program approved by the National Forest Reservation Commission contemplates the ultimate acquisition of approximately 9,000,000 acres more, or eventual Federal ownership of approximately 16,000,000 acres, which would be about 4.3 per cent of the estimated forest-land area east of the one-hundredth meridian. By the act of March 3, 1931, the purchase of not to exceed 50,000 acres for addition to the Luquillo Forest in Porto Rico was authorized by Congress.

During the year nearly 550,000 acres were approved for purchase at a cost of approximately \$1,944,000. The rate of progress is determined by the yearly appropriation, which since 1929 has provided \$2,000,000 annually. In accordance with the administration program for curtailment of expenditures the disbursement from the 1932 appropriation will be limited to \$1,700,000.

The transfers of land from national forests to national parks made during the year are instances of a long series of proposals of such transfers which have been almost continuous for 20 years. A number of the western national parks have been created from portions of national forests, and several others are surrounded by national forests. Necessarily many question as to the best boundary adjustments have arisen. Often the proposals have originated in local desires for anticipated local advantages. Each accomplished transfer has required a specific law. It should not be difficult to formulate definite standards of quality and function that will afford clear-cut differentiation between the lands that will serve their highest public usefulness as national parks and the lands more suitable for national forests. The problem in every case is one of social, industrial, and political economy readily determinable by systematic analysis of major factors in the light of established principles of public policy. Local pressure for one or the other form of administration ought not to control the decision, as against the large public interest. The efforts of the two services charged with the responsibility for administering these two Federal undertakings to develop a common viewpoint on the principles and purposes that should mark off their respective fields and a procedure for resolving doubtful questions as to the areas best suited to one or the other form of administration, would be much more effective if a definite public policy were determined and established.

Forest Receipts

The receipts from the national forests totaled \$4,993,320.08, a decrease of \$1,758,233.14, due to decreased receipts from timber, which were only slightly more than \$2,600,000. Grazing receipts, on the other hand, of nearly \$2,000,000, were a little greater than those in 1930, as were also the receipts from miscellaneous land uses; these came to more than \$400,000. Timber-sale receipts reflected chiefly the nation-wide decrease in lumber production.

Overproduction and market demoralization have been chronic in the lumber industry for years. The national-forest timber-sale policy has therefore withheld offerings of timber that would initiate new manufacturing enterprises except to utilize overmature stands, to check insect infection or disease epidemics, to salvage dead or dying timber, or to assist dependent local communities. On the other hand, where going mills needed new timber national-forest stumpage has been made available, to promote industrial and community stability. By direction of the President, the policy of restriction of national-forest timber offerings was given redefinition and added emphasis near the close of the year. During the present economic situation sales in excess of \$500 will be made only to supply the needs of existing sawmills dependent for their new material upon the national forests and unable to obtain it elsewhere, to furnish domestic paper mills with raw material needed to supply the domestic market with newsprint and other wood-pulp products, and to dispose of windthrown, insect-infested, and fire-damaged or fire-killed timber.

Cooperation with States in Forestry

Cooperation with States for the promotion of forestry is provided for under the Weeks, Clarke-McNary, and amendatory laws on a scale set by the annual appropriations. The forms of cooperation are: (1) Maintaining organized systems of protection against forest fires; (2) producing and distributing to farmers forest-planting stock; and (3) farm-forestry extension. In 1931, 45 States and 2 Territories cooperated in at least one form, 20 States in all three forms, and 19 in two. To the cost of protection the cooperating States contributed \$4,000,000, and to planting-stock production and distribution nearly \$250,000. The ratio of State to Federal expenditures for the first purpose was 3 to 1, and for the second, also 3 to 1. In addition private agencies contributed to the protection funds \$1,100,000. The area protected, 228,000,000 acres, was about 4,000,000 acres greater than that protected the previous year. Since 1925 there has been an increase of 50,000,000 acres, and an enormous upbuilding of State forestry activities, legislation, and general public interest.

The laws authorizing the three forms of cooperation limit Federal participation in each State to one-half the total outlay in that State, for the same purpose. With appropriations that do not permit a Federal matching of State expenditures, the department seeks to apportion the amount available along the most equitable and serviceable lines. The Federal participation varied from an even division of the cost in 10 States to a less than one-seventh share in 4 States. For all States combined the Federal funds made up 25 per cent of the total expenditures, State funds 60 per cent, and private funds 15 per cent.

When the Clarke-McNary law was passed, it was commonly held that for private forest land the owners should meet half the cost of protection, with the States and the Federal Government dividing equally the other half. It has become plain, however, that a large portion of the private forest land in the country is not regarded by its owners as having sufficient promise for permanent timber growing to be worth protecting at their own cost after the merchantable stand has been removed. The prospect is that much cut-over land will be abandoned in preference to paying taxes on it. The necessity of meeting protection costs, where this is required, makes abandonment the more probable.

Research in Forestry

The use of private land, whether now forested or cleared, for timber growing, hinges on the returns that can be looked for. Timberland owners will not make expenditures to keep their lands productive without a reasonable prospect that the investment of capital involved will turn out well. It is common to assume that timber raising is bound to pay. The lumber industry, on the other hand, is profoundly discouraged regarding the future. Enough is not yet known about costs, future returns, and methods to afford private capital an adequate guide as to where to practice forestry and what kind of forestry to practice. Further research, economic, industrial, and silvicultural, is necessary. It is needed as a guide to public policy and a requisite for public forestry, no less than as a means for furthering private forestry.

The appointment by the President of a timber conservation board has given prominence to the need for better economic data on the whole timber situation. The Forest Service is carrying forward a comprehensive long-time program of forest research, chiefly through a system of regional forest experiment stations as a central laboratory for research in forest products. The forest experiment stations conduct economic as well as silvicultural research. They are making real headway in building up the body of knowledge necessary for forestry.

WILD LIFE

The Bureau of Biological Survey has continued research work for the solution of complex problems in the conservation and propagation of waterfowl and big game and fur mammals, and in the protection of insectivorous birds and other forms of wild life. It has continued cooperative work for the control of economically injurious species.

The cause of wild-duck sickness, long a baffling problem, was determined during the year. This disease has been taking an intermittent but heavy toll from waterfowl and shore birds for more than two decades. During certain years the mortality on some of the important concentration areas has been far greater than the total kill there by hunters. Though earlier studies (in 1914-1916) conducted under the highly saline conditions about Great Salt Lake, Utah, pointed to certain alkaline salts as the cause, evidence from the past two years' study in Oregon, California, and Utah has demonstrated that the disease is a form of botulism produced by a toxin liberated by bacteria that thrive in decaying animal and vegetable matter. Technically the organism is *Clostridium botulinum*, type C, best known as a cause of limber neck in domestic poultry. Remedial measures can now be taken to prevent

high concentrations of alkaline water; this will serve as a preventive of the duck sickness as now understood, because the substitution of deep fresh water of a constant level for expanses of shallow water and mud flats, with their attendant decay of organic matter, eliminates important factors favorable to the disease.

To coordinate wild-life disease investigations a new unit was established this year in the Bureau of Biological Survey, under which cooperation was continued with other bureaus of the department and with the Universities of Minnesota and Southern California. Close observations on concentration areas of wild fowl, on numerous fur and game farms throughout the country, on game refuges, and on large areas of controlled natural habitat have made it evident that disease takes a large toll of wild life and that conservation measures should include disease control as developed by research.

Observations in Drought-Stricken Waterfowl Grounds

Investigations conducted throughout the entire country, and on important breeding grounds in Canada, indicate that the status of migratory waterfowl is more serious generally than at any time since the need was recognized for the migratory-bird treaty of 1916. Drought conditions on the breeding grounds in Canada and in the western part of the United States increased in intensity during 1930, and up to the middle of June, 1931, showed no indication of abatement. The hatch of young ducks in the Prairie Provinces of Canada in 1930 was only about half that of normal years. In this great area are bred the major part of the most commonly hunted wild ducks found in the United States during the fall and winter months. The Biological Survey has conducted continuous observations in the drought-stricken areas and has cooperated with Canadian authorities in an effort to obtain reliable information regarding critical conditions during the spring and summer, so that necessary safeguards for the wild fowl may be maintained.

Changes in Waterfowl-Season Regulations

After consulting the advisory board under the migratory-bird treaty act, the Biological Survey recommended regulations, and these were approved, to reduce the 1931-32 season on ducks and geese by two weeks throughout the United States. To accomplish the greatest possible saving of these birds the time was taken from the beginning of the season in the Northern States and from the end in the South. In 1930 the daily bag limit on ducks had been reduced to 15 and that on geese to 4. Other amendments to the regulations restrict to 10 the number of live-geese decoys that may be used at a gunning stand and make it illegal to shoot mourning doves over baited fields. Drought conditions over three years on waterfowl-breeding areas made limitation of the annual kill imperative, and on August 25, after the close of the fiscal year, continuation of acute waterfowl conditions made it necessary to reduce the open season throughout the country to one month.

Economic Importance of the Wild-Fowl Resources

The value of game birds becomes increasingly apparent; not only are they of great recreational value, but they also constitute an important game-food supply, and the upland game birds assist agriculture by

destroying weed seeds and insects. Many thousands of families have had living conditions made more agreeable by a game-food supply or by income derived from hunting and providing for the needs and entertainment of hunters. In one State alone during the open season of 1930 more than 2,350,000 wild ducks were killed. The total annual kill of wild ducks throughout North America in recent years has probably been between 10,000,000 and 15,000,000.

The Federal wild-fowl conservation policy has been set forth in the terms of the migratory-bird treaty act, which was passed to protect these birds through regulating the annual kill, and of the migratory-bird conservation act, a measure enacted to insure the permanent establishment of from 60 to 100 great national wild-fowl sanctuaries. The department, through research to eliminate losses from disease, by careful regulation of the annual kill to prevent waste and exploitation, and by the development of a refuge system, is endeavoring to maintain the abundance of migratory birds.

Migratory-Bird Refuges

During the first two years of the 10-year national program for the establishment of refuges for migratory game birds, approximately 4,000,000 acres in some 200 units have been studied to ascertain the nature of the wild-fowl food resources; land-valuation surveys looking toward purchases were made on 115 of these units, involving more than 3,000,000 acres in 41 States. The Migratory Bird Conservation Commission has approved the acquisition by purchase or lease of 111,517 acres at an average cost of \$3.87 an acre, in California, Colorado, Florida, Nebraska, North Carolina, and South Carolina. By Executive order four refuge areas have been reserved from the public domain in Montana, Oklahoma, Nevada, and California. Added to the lands approved for purchase, these areas bring the total acquisition under this program to 176,244 acres—representing nine migratory-bird refuges.

Musk Oxen Reintroduced into Alaska

In the summer of 1930, 34 musk oxen were obtained by the Biological Survey through a dealer who captured them in northeastern Greenland. After their sea voyage to New York, by way of Norway, they were held in quarantine a little more than a month as a precaution against the introduction of diseases that might be inimical to other species, wild or domestic. They were then taken by rail to Seattle, Wash., by steamer to Seward, Alaska, and again by rail to the bureau's reindeer experiment station near Fairbanks. Musk oxen formerly occurred in Alaska but disappeared previous to the occupation of their range by Europeans.

Control of Injurious Wild Animals

In the interests of all branches of agriculture, forestry, and game protection the Bureau of Biological Survey has cooperated for more than 15 years with State and other organizations in work for the control of predatory wild animals and injurious rodents. A special program of control drawn up by the department to cover a 10-year period and authorized by Congress during the year will make more effective the work as already organized. It will also enable the Bio-

logical Survey more adequately to conduct and supervise control operations. The leadership of the department in this work has been requested and encouraged by State and other agencies, and the funds made available from such sources for expenditure under the direction of the Biological Survey have been far in excess of those provided for the purpose from the National Treasury.

HOME ECONOMICS

The work of the Bureau of Home Economics during the past year was adjusted so far as possible to meet the needs of homes with incomes reduced by the drought and unemployment. Advice and assistance to home makers were furnished through correspondence, radio broadcasting, press releases, and printed bulletins. These efforts were designed to serve household needs, to improve standards of living, and to promote wise use of agricultural products in the home. The program included special studies in low-cost diets, the preparation of food guides for use of extension workers and others in the drought areas, and the dissemination of facts as to cheap sources of "protective foods," especially those containing the factors that prevent pellagra. Thousands of charts and leaflets were distributed for this purpose. In response to a call from the women's division of the President's Emergency Committee for Employment, similar service was extended to families with incomes reduced by unemployment. Recipes for low-cost diets were worked out and distributed.

In cooperation with other institutions the bureau studied the selection of food for children. A report has been prepared indicating the part the nursery school can play in providing adequate meals for children from 2 to 6. Another publication, *Food for Children*, based on an experiment in child feeding at the Washington Child Research Center, has been issued.

The bureau participated in the work of the White House Conference on Child Health and Protection. It is represented on the planning committee of the President's Conference on Home Building and Home Ownership, which is collecting data that should be of great value in bettering housing and home-living conditions.

Study of Consumer Needs

Dietary surveys of different population groups are in progress. The records, showing consumption trends, are checked against nutritive needs to guide both production and consumer demand. Other investigations deal with the quality of agricultural products. Tests of the palatability of meat as affected by different production factors and by different methods of cutting, handling, or cooking are conducted in cooperation with the Bureau of Animal Industry and the Bureau of Agricultural Economics. The meat used is produced at State agricultural experiment stations. The effect of breeding, fertilization, and storage upon the cooking quality of potatoes is tested in cooperative studies with the Bureau of Plant Industry and the Bureau of Chemistry and Soils. Comparative cooking tests on eight native-grown varieties of rice have shown different lengths of time for satisfactory cooking, thereby lending support to the contention that varieties should not be mixed for marketing.

Studies of Fabrics

Studies of fabrics deal with the wearing qualities of household materials manufactured from different grades of cotton and wool. Sheets and blankets manufactured from different grades of these materials are tested under controlled conditions of constant use.

Textile-utilization experiments were continued to determine new and more satisfactory uses for fibers grown in this country. The results were made available in popular publications. A farmers' bulletin on window curtaining, a leaflet on slip covers, and another on furnishing living rooms were prepared to encourage a wider use of cotton materials, as well as to help farm families in improving their homes.

Basic Research

Investigations were continued regarding the standard of living of families on marginal farms in the Appalachian highlands. Information thus obtained was correlated with facts regarding the size and sources of family incomes, the types of soil farmed, the uses made of land, and the character of the schools and other community facilities. Preliminary reports were presented at a conference with the extension service of the University of Kentucky, and at a meeting of the Kentucky Home Economics Association. A second survey was begun in June in Grayson County, Va., an Appalachian community of a somewhat different type.

A study of the food supply of 73 families on marginal farms in South Carolina, where pellagra is prevalent, compared the food habits of families that had escaped the disease with the food habits of families that had not escaped it. It also included comparisons with families of similar economic status and similar diet in mountain regions of Kentucky. The study showed the beneficial effects of adding different amounts of certain pellagra-preventive materials to the diet.

The use of wheat germ and rice polish is recommended in communities where the diet commonly lacks vitamins B and G. These products, however, tend to grow rancid under the usual conditions of storage, and their use is consequently limited. Accordingly a method was sought whereby the home maker might retard the tendency. It was found that wheat germ and rice polish may be preserved by heating them for 9 or 10 minutes in a $\frac{3}{4}$ -inch layer at 190° C. Formulae were worked out for enriching corn meal with dried skim milk or a combination of dried skim milk and wheat germ or rice polish. Wheat germ is as rich in vitamin B (the antineuritic vitamin) as yeast, and one-half to one-third as rich in the antipellagra vitamin G. Cottonseed flour, slightly less rich in both vitamins, would afford ample amounts of the pellagra-preventive factor for most diets, if used in the quantities found desirable for baked products.

Experiments with meat held at different temperatures showed that the development of bacteria advances markedly at temperature above 50° F., and that meat should be kept at the same low temperature as that recommended for milk (45° or below).

FOOD AND DRUG ADMINISTRATION

The Food and Drug Administration, a separate bureau of the department, is charged with the duty of enforcing the food and drugs act, the insecticide act, the tea act, the naval-stores act, the import-milk act, and the caustic-poison act.

The independent-bureau status of the Food and Drug Administration is emphasized here because a mistaken idea prevails in some quarters that analytical work incident to the enforcement of these various laws is performed by another bureau of the department, administrative details alone being centered in the Food and Drug Administration. A natural inference from such a misunderstanding would be that the regulatory operations are subject to divided control, a situation which obviously would be conducive to bad administration.

June 30, 1931, marked the twenty-fifth anniversary of the passage of the food and drugs act. Since the measure was passed, revolutionary changes in the food habits of Americans have taken place. Manufactured foods have become a stable and highly important item in the diet of those who live on the farm, as well as of those who dwell in cities. The progressively increasing demand for commercially prepared foods has effected marked changes in manufacturing methods and brought into the field large numbers of new manufacturers. This, and an increasing expansion in the drug and medicine manufacturing trades, have thrown a heavy burden on the Food and Drug Administration. Necessarily limited in personnel and working funds, the administration has concentrated on types of violations which endanger the public health and constitute serious economic frauds upon the consumer. While various attempts to weaken the act have been unsuccessful, and while in general the broad terms of the measure have been remarkably effective, the experiences of the last 25 years have clearly shown that the measure in its present form does not insure all the safeguards to the American consumer that its framers presumably intended. Consequently the department expects to recommend desirable amendments to the act.

Prosecutions and Seizures

In the course of import and interstate operations under the food and drugs act during the fiscal year ended June 30, 1931, the administration collected and examined 31,859 samples of foods and drugs. Prosecutions and seizures under the law numbered 991 in the case of foods, 885 in the case of drugs, and 101 in the case of livestock feeds, totaling 1,977 actions. Import inspections resulted in the passing of 4,899 shipments of food and 1,842 of drugs, while 2,469 shipments of food and 1,321 of drugs were detained. Since the passage of the law more than 18,000 legal actions have been instituted, involving both the seizure of offending goods and the prosecution of shippers.

McNary-Mapes Amendment

New tasks were imposed upon the technical forces of the administration by the passage on July 8, 1930, of the McNary-Mapes amendment to the pure food law. Since no special appropriation was made for carrying on work under the amendment, many technical investi-

gations of the administration were temporarily forced into the background following the passage of the measure. The formulation of standards of quality and of condition and fill of container is necessitated by the amendment. Six important classes of canned foods were chosen for preliminary work. These were peas, peaches, pears, apricots, cherries, and tomatoes, for all of which standards were promulgated during the year. The designation "Below U. S. Standard. Low Quality, but not Illegal" was adopted for use in labeling substandard products.

Corn Sugar Under the Food and Drugs Act

On December 26, 1930, a decision defining the status of corn sugar (dextrose) under the law was announced in the following terms:

Corn sugar (dextrose) when sold in packages must be labeled as such; when sold in bulk must be declared as such; but the use of pure refined corn sugar as an ingredient in the packing, preparation, or processing of any article of food in which sugar is a recognized element need not be declared upon the label of any such product.

Nothing in this ruling shall be construed to permit the adulteration or imitation of any natural product, such as honey, by the addition of any sugar or other ingredient whatever.

In order to bring the existing definitions and standards for food products into conformity with this decision, the definitions and standards as previously published were revised.

Offenses Involving Public Health

Foods may become dangerous through contamination with poisons, through the development of certain forms of bacteriological decomposition, or through the presence of disease germs. To-day, such contamination is rare in commercially packed foods. The increasing efficiency of commercial food-manufacturing methods in the United States is illustrated by the fact that in the last two fiscal years the administration has encountered no cases of botulism attributable to commercially packed food.

The canning of prunes, an expanding industry in the Pacific Northwest, necessitated some control by Government agents. The 1930 pack, 660,000 cases, was considerably smaller than that of 1929, due to unfavorable weather. The harvest season for prunes in the Pacific Northwest generally comes in September, and at that time last year continued rains and cloudy weather were responsible for the rapid development of brown rot which infected approximately 40 per cent of the crop and caused heavy losses to the industry. The heavy infestation required immediate regulatory action. Officials collected 49 official and 108 investigational samples for examination. This resulted in 20 seizures, involving about 4,500 cases of canned prunes.

A significant legal action concluded during the year involved the interstate shipment of approximately 43,000 cases of canned salmon, found to be partly decomposed. Following seizures of the goods, criminal prosecution was instituted, and the Federal judge of Seattle, Wash., imposed fines of \$350 and \$300 upon the two offending shippers, at the same time expressing regret that the limitations of the statute prevented the imposition of jail sentences.

Actions Involving Drugs

The Food and Drug Administration tries to protect the public against patent medicines bearing curative claims far in excess of their actual merit. Fraudulent claims made regarding the curative value of an illegal remedy have always been regarded by the department as a definite public menace. During the past fiscal year 570 seizures of falsely and fraudulently labeled proprietary medicines were made.

During the calendar year 1930, 6,189 cans of anesthetic ether were examined. Of these, 313 were found not of United States Pharmacopoeia quality; 82 lots were libeled. A 5-year campaign against impure or low-quality anesthetic ether has resulted in a marked improvement in the quality of this important product. Of 470 cans examined in 1926, 162, or 34 per cent, were found to be low in quality and unfit for anesthetic purposes. Only 5 per cent of the cans examined in 1930 were found to fall in that class.

Worthless Veterinary Preparations

Progress has been made in the department's efforts to protect the farmer against ineffective veterinary remedies. Interstate commerce has now been cleared of preparations falsely and fraudulently labeled as having therapeutic value in contagious abortion of cattle, hog cholera, and tuberculosis of livestock. Careful surveillance was maintained over proprietary veterinary preparations labeled as having therapeutic value for other diseases of farm livestock and poultry. Internal parasites are of considerable economic importance to the farmer in that they cut down the producing ability and thus the value of his animals. Critical tests of a number of vermifuges were made. An important case, involving a group of veterinary preparations falsely represented as treatments for black tongue, distemper, and running fits of dogs, was concluded at New Orleans when the Government secured a verdict in a contested action.

Other Regulatory Activities

Nearly 1,500 insecticides and fungicides were examined and, when necessary, submitted to field tests. Thirty cases, representing apparent violations of the law, were reported to the Department of Justice for criminal or seizure proceedings. Disposition of 447 cases involving misbranded insecticides and fungicides was made. When the mislabeling was called to the attention of the manufacturers, they voluntarily made the necessary changes, making it unnecessary for the Government to resort to legal action. Many new combinations in insecticides and fungicides appeared upon the market during the year, requiring considerable laboratory analysis and testing.

A country-wide survey, begun in 1928, of products subject to the caustic poison act was completed. At the close of the fiscal year 1931, 70 per cent of the many thousands of labels encountered were in exact compliance with the requirements of the law. During the year 1 seizure under the act was instituted, and 16 additional cases are in the course of development.

Under the service features of the naval stores act the department's classifiers graded 181,429 barrels of rosin. The collections for this service work, which were turned over to the United States Treasury

as miscellaneous receipts, amounted to \$13,913.62. Two prosecutions covering definitely willful violation of the naval stores act were terminated successfully.

The quantity of tea offered for importation during the fiscal year 1931 was 87,091,330 pounds, an increase of about 2,500,000 pounds over the total importations for the fiscal year 1930. Slightly over 49,000 pounds were rejected, this being only 0.057 per cent of the total quantity offered for entry.

Enforcement of the import milk act is centered at Rouses Point, N. Y., in the heart of the section through which most of the milk from Canada enters the country. As a result of farm and plant inspection work provided for under the act a change for the better has taken place in the sanitary condition of dairy farms, and in plant practices. This improvement was reflected in importations of milk and cream of a uniformly high quality. Many of the plants under supervision have installed a definite farm-inspection and milk-testing system as a routine practice. During the fiscal year 1931, 170 plants and 1,756 dairy farms were inspected. Products from 143 dairy farms were embargoed, and 50 foreign farms were released from previous embargoes. One hundred twenty-five permits to import were renewed.

TRADING IN GRAIN FUTURES

Trading in wheat futures in the United States showed a sharp decrease as compared with such activity during the previous fiscal year. The total volume of trading on all exchanges designated contract markets under the grain futures act of 1922 amounted to 10,063,139,000 bushels during the year ended June 30, 1931. While this is nearly 50 per cent less than the volume for the previous year, when total sales aggregated 19,606,790,000 bushels, it nevertheless exceeds the low record in 1923-24 by about 38 per cent.

Decreased activity in wheat futures was due in part to the shifting of speculative interest to corn, where a short crop and a closer adjustment between supply and demand furnished greater incentive to speculation. This was reflected in a 50 per cent increase in the volume of trade in corn futures over that of the previous year. Trading in corn futures during the fiscal year ended June 30, 1931, amounted to 5,505,123,000 bushels, as against 3,667,885,000 in 1929-30. The last-named figure, however, was the smallest of record and showed about half as much trading as was done in 1924-25 and in 1927-28.

Some of the decline in trading in wheat futures resulted from the stabilization activities of the Federal Farm Board, in that speculation was naturally reduced in the December, March, and May futures, which were supported by the Grain Stabilization Corporation. Not all of the decline, however, can be attributed to that cause. The unusually large stocks of wheat, a limited foreign demand accompanied by declining prices, and the unsettled condition of the stock market and business generally throughout the world had a marked effect in minimizing speculative interest of all kinds. In this connection, it may be noted that while trading in all grain futures combined during the year ended June 30, 1931, was 17,034,201,000 bushels as against 24,999,650,000 the previous year, a decrease of about 32 per cent, the decrease in the trading in securities on the New York Stock Ex-

change during the same period was even greater. The number of shares sold from July 1, 1930, to June 30, 1931, amounted to about 667,000,000 as compared with 1,080,000,000 the previous year, or a decrease of about 38 per cent.

Though the volume of trading in wheat futures during 1930-31 was relatively small, the amount of open contracts reported to the Grain Futures Administration by members of contract markets was large. This contrast is largely explained by the heavy stocks that were carried forward and hedged. It appears that the hedges were absorbed and carried mainly by the so-called general public and by the Grain Stabilization Corporation, which bought large quantities of wheat in the futures markets and took delivery. The general public composed of small traders is usually found on the buying side. It was on the buying side last year, when prices were declining. On the other hand, the so-called large professional traders operated primarily on the short side. This may have reflected superior judgment on their part, but it certainly added to the load on the bear side of the market. Hedgers, however, had a fair measure of protection during the year owing to the prevailing favorable relationships between cash-grain prices and prices in the futures markets.

Stabilization Operations

Special interest attaches to the results of stabilization operations conducted by the Federal Farm Board between November 15, 1930, the date when stabilization was authorized, and May 30, 1931, when the May future expired. These operations related to the 1930 wheat crop, and established the basis upon which most of that crop was sold. Prior to November 15, Chicago July wheat had sold slightly above the May wheat, but prices had steadily declined since the second week in August. The July future at Chicago continued to decline. It sold below 60 cents in March and again in April and May, 1931. The May price, on the other hand, was stabilized by the Federal Farm Board at above 80 cents throughout most of this period. After stabilization was discontinued the price of the July future declined to lower levels, and on the last day of July sold under 50 cents. Chicago May wheat during January, February, March, April, and May was above the Liverpool price by from 15 to 20 cents a bushel. Normally, when the United States has an exportable surplus of wheat, the Chicago price is below the Liverpool price. Besides being held at a higher level during the stabilization period, the May future was kept within a very narrow range of fluctuation. The average daily range from November 15 to May 30 in the May future was only half a cent a bushel, whereas in the July future the average daily range was 1½ cents. In the dominant futures from May 1, 1930, to November 15, 1930—that is to say, in the five and one-half months preceding the board's stabilization operations—the average daily range was 2½ cents. It is thus obvious that much of the 1930 wheat crop brought prices considerably higher than the prices that would have ruled had the Federal Farm Board not entered the market.

Action Needed to Correct Abuses

Grain exchanges and grain-futures markets play an important part in our marketing system. The hedging facilities which are offered millers and dealers generally serve useful purposes, and, on the whole, these

markets function efficiently. Action is required, however, to eliminate certain abuses. I referred to this matter in my annual report last year and wish to reaffirm here what I then said. Legislation to strengthen the present grain futures act seems desirable, to eliminate sharp practices in the handling of customers' orders, and to afford a safe and sure means of control over the purely speculative trading of large operators. Under existing conditions the unrestricted opportunity to buy or sell futures enables large traders at times to take advantage of technical situations to the disadvantage, not only of producers and cash handlers of grain, but of the small traders composing the general trading public. Small traders are necessary to maintain a liquid futures market. They should be guaranteed fair play and a fair chance against those with larger means. This is said not to encourage speculation but to emphasize the necessity of making the future-trading system equitable. It should extend equal opportunity to all traders so that its benefits may flow as directly as possible to the producers of grain and the handlers of actual grain and grain products. Existing legislation does not give the Federal Government authority to limit excessively large speculative lines or to limit short selling calculated to demoralize prices.

EXTENSION SERVICE

Supplementing sources of farm income and maintaining as good a standard of living on the farm as possible with the income in hand were the chief problems to which extension workers gave attention this year. Price-breaking surpluses of wheat and cotton necessitated large production adjustments. The development of new sources of income became imperative. Supplemental lines of production had to be considered and adopted. County extension agents were constantly busy studying the situations in which producers found themselves individually and collectively. Reliable and practical information from State agricultural colleges and the department was in pressing demand. Consulting with farmers as to their operations is not a new activity of extension agents. Crop adjustments have been made with the aid of extension workers in many counties and in entire States. It is a recent development, however, for the entire force of the cooperative extension service to direct its attention largely to problems of agricultural adjustment the country over. Extension problems this year were more numerous, more complex, and more widespread than ever before.

The California Extension Service reported striking results from a 10-year campaign to put dairying on a sound and profitable basis. Production was so increased in volume and efficiency that California's dairy industry in 1930 had a gross income \$25,000,000 greater than that of 1920. The campaign was undertaken following a thorough study of the industry's requirements, prominent among which was greater stability. The objectives were outlined, and the work was conducted steadily to a successful issue.

Extension workers this year helped producers throughout the country to map out programs. Where it seemed advisable to curtail or abandon a line of production, substitute crops or enterprises were considered. Many farmers were encouraged to develop new activities. They undertook in increased numbers to grow home and farm supplies as much as possible and to build up reserves of feed, seed, and

livestock. North Carolina produced \$20,000,000 worth of food and feed more than in 1930. This is an outstanding example of the advantages obtained. The farm women and girls of that State are credited with putting up 2,250,000 quarts of home-grown fruits and vegetables in the past season.

Soil-Improvement Systems Adopted

In many districts definite systems of soil improvement were adopted, wood-lot and forest-area developments were started, and minor cash enterprises were launched to make up deficiencies in the income from major crops. Closer attention was given to the grading, pooling, and selling of marketable crops. Existing cooperative-marketing associations were strengthened and new ones organized. The establishment of credits on a sound basis was promoted and the use of credit encouraged where adequate returns could be expected. In this last effort local banking institutions and bankers' associations cooperated.

The department and the State agricultural colleges speeded the assembling of economic facts applying to local conditions. At a series of four regional conferences, State and Federal extension workers and economists considered available data. State workers returned to their own fields better equipped to aid in appraising local situations. At local conferences producers were helped to plan their individual farm programs. To strengthen this work 120 economic workers were added to the extension forces.

Home demonstration agents assisted farm women and girls in preparing and selling surplus garden, poultry, and dairy products. The development of home industries progressed. More than 200 operators of roadside markets attended a conference held in New Hampshire at the instance of the State extension service. The West Virginia Extension Service began the promotion of attractive tourist homes and supplemental home industries as sources of income to farm families. Farm women and girls were helped also in the economical buying of supplies, in the preservation of home-grown foods, in the making and remodeling of garments, in the refinishing of furniture, in the making of inexpensive improvements in the house, and in the planting and care of flowers and shrubbery. No other phase of home-demonstration work met with more appreciation than that resulting in the beautifying of the home and its surroundings.

Boys and girls joined in the general effort to augment farm incomes and maintain farm living standards. More than 845,000 were enrolled in 4-H clubs, in which, under the supervision of extension agents, they studied and demonstrated efficient farming and home making. The growing of cotton, corn, potatoes, and other vegetables and the care of calves, pigs, and poultry gave them training in production and marketing. Their activities included preserving fruits and vegetables, cooking and serving meals, making and remodeling clothing, and furnishing and decorating rooms.

The field force employed in extension work on June 30, 1931, totaled 6,179 persons, an increase of 219 over the number last year. In the counties 2,382 county agents, 234 assistant agents, and 167 negro agents were employed. The home economics staff included 1,241 county home demonstration agents, 36 assistant agents, 10 urban agents, and 123 negro agents. Two hundred and eighteen county club

agents and 33 assistants devoted full time to 4-H clubs. Practically all county extension agents gave some time to boys' and girls' clubs. To reenforce the efforts of county extension agents and to assist in dealing with specialized problems there were 1,222 extension specialists stationed usually at the State agricultural colleges. The administrative and supervisory staff in the States numbered 495 persons.

Appropriations for Extension Work

Federal appropriations amounting to \$6,192,936 were allotted to the 48 States and the Territories of Hawaii and Alaska for extension work under the terms of the Smith-Lever Appropriation Acts and \$1,480,000 was allotted under the terms of the Capper-Ketcham Act. A special appropriation of \$1,000,000 for allotment to the States was made available by the Congress, primarily for extension work in economics and marketing. The direct Federal appropriation for extension work was \$1,755,000, of which \$1,550,000 was for farmers' cooperative demonstration work and motion pictures, \$15,000 for general administrative expenses, \$120,000 for exhibits, and \$70,000 for farm-forestry extension. The States, counties, and other agencies contributed \$15,876,250 for cooperative extension work. The total of all these items available for cooperative extension work with the State agricultural colleges and for motion pictures and exhibits was \$26,304,186.

INFORMATIONAL WORK

When times are hard for the farmer, technical and economic information that he can put to practical use becomes all the more necessary. The department, consequently, increased its efforts this year to give the public information developed by its research, service, and regulatory activities.

Increased funds, made available by Congress for printing and binding, permitted increased publishing. Manuscripts sent to the printer totaled 1,737, as compared with 1,702 in the previous fiscal year. The number included several emergency publications necessitated by drought and unemployment relief work. Publications are the permanent foundation of the department's informational work. For years there has been considerable delay between the completion of a research project and the publication of the results; now this gap is being narrowed. In the act creating the Department of Agriculture, Congress made the dissemination of knowledge by the department as important a duty as the acquisition of knowledge. Evidence of the extent to which this function is being discharged is furnished by the demand for the department's publications, which are not foisted upon persons who do not desire them, but are mailed only on request. Hence, the fact that nearly 32,000,000 copies of various classes of publications were distributed in the last fiscal year indicates that the publication program is adapted to its purpose. Approximately 12,500,000 of the publications distributed were farmers' bulletins, and 2,058,538 were leaflets. About 17,000,000 copies of technical, semitechnical, periodical, and miscellaneous publications were issued.

Press Aids Department

It would be difficult to overvalue the help of the press in disseminating agricultural information, particularly in times of economic disturbance, when speedy communication is essential. All scientific facts should be made known quickly. Economic information especially demands almost instantaneous distribution. The press furnishes valuable aid in doing this. Press cooperation is particularly valuable in disseminating data about crops and markets. The press also devotes much space to results gained by the department in production studies, in the control of animal and plant pests, in chemical research, in meteorology, in forestry studies, in wild-life conservation, and in home economics. Though most publications have been forced by the depression to reduce their size, releases issued by the department seem to have been used about as fully and widely as formerly. It is generally recognized by the press, both daily and periodical, that the material issued by the department has practical value. This is shown by a growing demand, not only for press releases, but for articles by the department's specialists. Press associations and syndicates carry such articles regularly.

The Radio Service

Important advances continued during the year in the department's radio work, further enhancing the valuable service rendered agriculture by this new medium of communication. Radio broadcasting makes available to the farmers much economic and technical information that might otherwise not reach them or might reach them too late to be of full value.

A new network program, originating on the Pacific coast and broadcast in the Pacific and intermountain regions by 8 stations associated with the National Broadcasting Co., was started. In the last two years the department's broadcasting has grown tremendously. In the early part of 1929, it issued one network program through 17 radio stations. It is now issuing two daily programs and one weekly network program through 55 radio stations. Two years ago it put out syndicate programs through 164 stations. Similar manuscript programs now go to the audiences of 234 stations.

Land-grant colleges are cooperating with the department in extension broadcasting, and in surveying broadcasting requirements and possibilities. The projected Federal-State extension program envisages daily 15-minute syndicate programs broadcast through more than 250 cooperating commercial stations. One-third of the land-grant colleges themselves operate radio stations.

It was found desirable in broadcasting to continue emphasizing economic information. The national farm and home hour, the western farm and home hour, and department programs on more than half the individual stations in the United States proved effective means of sending rush information to farm people throughout the country. Better cooperation between agricultural program makers and the nation's broadcasters is desirable. Better correlation between Federal and State subject matter is also necessary. Both these ends are being sought.

WEATHER BUREAU

Diminished precipitation last year and again this year over large areas was reflected in river stages which in the main were low. This circumstance enabled the Weather Bureau to repair its river gauges and verify zero points. It afforded an opportunity also to strengthen the river-stage service in other respects. Some additional river-stage stations were established. Recent engineering developments, including the building of fine roads and bridges, the development of water resources, and flood-protection work necessitate a more exact study of river stages and a more adequate flood-forecast service. The measurement of low-water stages, which formerly was relatively unimportant, now must be done with extreme care. The Weather Bureau took advantage of the exceptional conditions prevailing this year to improve its facilities for making these measurements. Important advantages are expected, particularly to river navigation, which depends mainly on the Weather Bureau for information about river stages and ice movements.

Extensions were made by the Weather Bureau during the year in its daily weather service, principally in the facilities for obtaining observations from ships in the North Atlantic, the South Atlantic, the Caribbean Sea, and the Gulf of Mexico. In accordance with international agreements, more reports were received from ships of foreign registry. Daily radio bulletins containing ship reports and observations from representative land stations in Europe and Asia were received. This information was particularly welcome because weather reports from overseas previously had not been received regularly. Such reports are now collected at the British Meteorological Office and transmitted to the United States Weather Bureau through radio stations at Rugby and Bar Harbor. Arrangements were made also for getting additional information on barometric changes, on the time and character of precipitation, and on humidity conditions in the United States and Canada.

To meet increasing demands for special forecasts for agriculture, aviation, and other interests, the Weather Bureau, with funds specially provided by Congress, began training forecasters. Candidates selected from members of the Weather Bureau were taught how to prepare maps and interpret weather reports. They received special instruction in meteorology, physics, and mathematics. After preliminary training in Washington, the class was distributed among field stations.

Service for Air Navigation

Following the passage of the air commerce act in 1926, the annual appropriations of the bureau have provided for notable extensions of its meteorological service in aid of air navigation.

At the close of the fiscal year June 30, 1931, approximately 9,400 miles of airways were provided with continuous, 24-hour service. This represented an increase for the year of about 3,400 miles. In addition, partial service (reports collected only for scheduled flights) was organized for about 3,000 miles of new airways, making a total of about 6,000 miles partially served, or a grand total of about 15,500 miles.

Along with the development of this network of frequent current reports, a system of airways forecasts every three hours was organized

with an extension during the year to three additional centers, Atlanta, Dallas, and Portland. With those previously organized at Cleveland, Oakland, Omaha, and Salt Lake City the country is well covered, except in the northern and southern Plains States and the extreme Northeast and Southeast.

Airways service in Alaska was extended by the establishment of a station at Nome with facilities for making pilot-balloon observations. Airways stations were established also at a number of other points. These stations report on schedule for plane movements by radio, telephone, or telegraph. A number of airways stations were established in the Hawaiian Islands to make reports for interisland flying.

Ten additional pilot-balloon stations were established during the year. One was established at Akron, Ohio, primarily to investigate the effect of wind gustiness on dirigibles.

AGRICULTURAL EXPERIMENT STATIONS

Through its Office of Experiment Stations the Department of Agriculture maintains close relations with the agricultural experiment stations of the several States and with those of Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands. It is cooperating with these stations in more than 1,000 research projects, or more than 15 per cent of the projects in which the stations are engaged. This cooperation economizes effort, coordinates different investigations, and prevents duplication of work.

The Federal Government contributes annually about \$4,500,000 to the experiment stations, whose total funds are approximately \$18,000,000 annually. Evidence of the value attached to these institutions is shown by the fact that their support from State and local appropriations and from donations and endowments has increased greatly in recent years. The money spent annually by the stations comes to about \$3 per farm in the United States. It is impossible to measure the money return, but it is unquestionably large.

Research in which the department cooperates with the stations covers national, regional, and local problems. It has to do with the needs of the farm home and with rural-community matters as well as with the production, distribution, and sale of farm products. The results are disseminated by colleges and schools of agriculture, as well as in textbooks, treatises, and bulletins. Experiment station findings obtain wide publicity, also, through the rural press and the radio. They are translated into farm practice especially through the extension services of the different States.

Activities of Insular Stations

Special efforts were made during the last year, through the agricultural experiment stations of Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, to improve agriculture and rural life conditions in these territories. The work was aided by certain important changes authorized by Congress and by local legislatures in the status of these stations. Under an act of Congress approved February 23, 1929, whereby the benefits of the Hatch Act were extended to Alaska, an experiment station was established in connection with the Alaska Agricultural College and School of Mines. A station operated by the department, at Fairbanks, Alaska, since 1907 was merged with the

new organization. This change will extend the scope, effectiveness and application of the research and service work undertaken. It will also encourage local participation in the work.

In Hawaii a consolidation of experiment station work under the joint supervision of this department and the University of Hawaii, which was provided for by an act of Congress passed May 16, 1928, brought about increased efficiency and economy. This legislation, like that passed with reference to Alaska, extended the benefits of the Hatch Act and supplementary acts to Hawaii.

A similar measure approved March 4, 1931, extended the benefits of the Hatch and supplementary acts to Porto Rico. This measure provided for the coordination of experiment station work in the island in accordance with plans approved by the Secretary of Agriculture. The required coordination is under way. It will bring about joint action by the Federal authorities, the insular stations, and other agencies interested in improving the agriculture of the island.

Federal research workers cooperated during the year with the experiment station in the Virgin Islands in efforts to improve agricultural conditions there. Important benefits are expected from a soil survey of a portion of St. Croix which was completed by the Bureau of Chemistry and Soils. Studies were made to determine whether the bay-oil industry, in which the Virgin Islands formerly excelled, can be improved. Federal entomologists cooperated with authorities of the experiment station in a survey to ascertain whether the pink bollworm could be controlled and the cotton industry restored in the islands.

ARTHUR M. HYDE,
Secretary of Agriculture.

FINANCIAL STATEMENT

Expenditures, Department of Agriculture, Fiscal Year 1931

Funds disbursed and obligated for work under appropriations administered by the Department of Agriculture during the fiscal year ended June 30, 1931, including road building, totaled \$313,543,238. These expenditures were distributed as indicated by Tables 2 and 4 and the tabulation following Table 2.

TABLE 2—Expenditures classified by organization units

Organization unit	General activities (all objects except payments to States, road construction, and relief loans)	Payments to States (exclusive of Federal-aid road funds)	Road construction (including Federal-aid road funds)	Relief loans	Total
Office of the Secretary.....	\$1, 182, 910	-----	-----	-----	\$1, 182, 910
Office of Information.....	1, 354, 989	-----	-----	-----	1, 354, 989
Library.....	104, 306	-----	-----	-----	104, 306
Office of Experiment Stations.....	405, 940	\$4, 340, 000	-----	-----	4, 745, 940
Extension Service.....	1, 729, 384	8, 672, 936	-----	-----	10, 402, 320
Weather Bureau.....	3, 934, 507	-----	-----	-----	3, 934, 507
Bureau of Animal Industry.....	15, 271, 992	-----	-----	-----	15, 271, 992
Bureau of Dairy Industry.....	795, 530	-----	-----	-----	795, 530
Bureau of Plant Industry.....	5, 570, 059	-----	-----	-----	5, 570, 059
Forest Service.....	15, 209, 211	3, 428, 166	\$18, 075, 332	-----	36, 712, 709
Bureau of Chemistry and Soils.....	1, 822, 701	-----	-----	-----	1, 822, 701
Bureau of Entomology.....	2, 631, 922	-----	-----	-----	2, 631, 922
Bureau of Biological Survey.....	2, 161, 090	-----	-----	-----	2, 161, 090
Bureau of Public Roads (including Division of Agricultural Engineering).....	² 1, 306, 531	(³)	162, 036, 683	-----	163, 343, 214
Bureau of Agricultural Economics.....	6, 696, 958	-----	-----	-----	6, 696, 958
Bureau of Home Economics.....	207, 020	-----	-----	-----	207, 020
Plant Quarantine and Control Administration.....	5, 293, 079	-----	-----	-----	5, 293, 079
Grain Futures Administration.....	166, 704	-----	-----	-----	166, 704
Food and Drug Administration.....	1, 626, 282	-----	-----	-----	1, 626, 282
Farmers' Seed Loan Office.....	-----	-----	-----	⁴ \$49, 519, 006	49, 519, 006
Total.....	67, 471, 115	⁵ 16, 441, 102	⁵ 180, 112, 015	49, 519, 006	⁶ 313, 543, 238

¹ Includes \$4,796,787 paid as Federal indemnities to livestock owners for animals destroyed in connection with tuberculosis eradication and \$5,650,503 for meat inspection.

² Includes \$575,026 for highway research and service activities, paid from appropriation for Federal-aid highway system.

³ \$155,312,613 paid to State highway departments for Federal-aid road work, included under column "Road construction."

⁴ Includes \$48,594,198 for loans to farmers in drought and storm stricken areas and for agricultural credit and rehabilitation loans, under special emergency appropriations, and \$841,231 for loans in storm and flood stricken areas and \$83,577 for collection of loans under regular appropriations.

⁵ See tabulation "Payments to States and road expenditures."

⁶ Including \$74,050,665 emergency funds. (See Table 3.)

Payments to States and Road Expenditures

(Analysis of "Payments to States" and "Road construction" included under Table 2)

1. PAYMENTS TO STATES

Office of Experiment Stations:

Payments to State agricultural experiment stations and to Hawaii for research under Hatch, Adams, and Purnell Acts..... \$4, 340, 000

Extension Service:

Payments to State agricultural colleges and to Hawaii and Alaska for extension work under Smith-Lever, Capper-Ketcham, and supplemental acts..... 8, 672, 936

Forest Service:

Payments to States under Clarke-McNary Act—

(a) Cooperative protection of State and private timberlands against fire (exclusive of \$80,200 for forest taxation and timber insurance studies, included under "General activities" in Table 2)..... 1, 618, 493

(b) Cooperative distribution of forest-planting stock..... 90, 798

Payments to States and Territories from national-forest receipts for the benefit of county roads and schools..... 1, 718, 875

Total, exclusive of Federal-aid roads..... 16, 441, 102

Bureau of Public Roads:

Payments to State highway departments for road construction under Federal-aid road act and supplemental acts (exclusive of \$575,026 for highway research and service activities, which is included under "General activities" in Table 2)-----	¹ \$155, 312, 613
Total, payments to States-----	171, 753, 715

2. ROAD CONSTRUCTION

(a) Under Federal-aid road act and supplemental acts:

Forest Service—

Construction of forest roads and trails----- ² 10, 824, 622

Bureau of Public Roads—

Payments to State highway departments for Federal-aid road construction (including \$1,675,436 for administrative expenses but exclusive of \$575,026 for highway research and service activities, the latter being included under "General activities" in Table 2)—

Normal construction----- \$135, 016, 347

Advances to States (emergency funds)----- ³ 20, 296, 266

¹ 155, 312, 613

Cooperation with States and Interior Department in the construction of public-land highways (emergency funds)-----

³ 24, 969

Total, Federal-aid road act (exclusive of highway research and service activities)-----

166, 162, 204

(b) Under Forest Service appropriations:

Construction of roads and trails ("General expenses" fund)-----

² 1, 952, 000

Construction of roads and trails (emergency funds)-----

² ³ 3, 052, 616

Construction of roads and trails for States (national-forest receipts fund)-----

² 763, 032

Construction of roads and trails ("Cooperative work" fund—contributions from private cooperators)-----

² 1, 483, 062

(c) Under special appropriations administered by Bureau of Public Roads:

Construction of highways within national forests (emergency funds)-----

² ³ 891, 524

Mount Vernon Memorial Highway-----

3, 398, 533

Restoration of flood-damaged roads and bridges in—

Alabama-----

430, 964

Georgia and South Carolina-----

1, 873

Missouri, Mississippi, Louisiana, and Arkansas-----

1, 589, 410

Vermont, New Hampshire, and Kentucky-----

386, 797

Total, road construction-----

180, 112, 015

¹ Included in both of above groups.

² Total for forest roads and trails, \$18,966,856.

³ Total paid for road construction from emergency funds, \$24,265,375.

TABLE 3.—*Emergency expenditures*¹ (included in Table 1)

Organization unit and object	General activities	Road construction	Relief loans
Emergency construction and employment (other than road work):			
Office of the Secretary.....	\$3, 381	-----	-----
Bureau of Animal Industry.....	45, 489	-----	-----
Bureau of Dairy Industry.....	56, 939	-----	-----
Bureau of Plant Industry.....	75, 000	-----	-----
Forest Service.....	² 695, 332	-----	-----
Bureau of Biological Survey.....	292, 988	-----	-----
Plant Quarantine and Control Administration.....	21, 963	-----	-----
Total, emergency construction and employment (other than road work).....	1, 191, 092	-----	-----
Emergency road construction:			
Forest Service.....	-----	³ \$3, 052, 616	-----
Bureau of Public Roads.....	-----	⁴ 21, 212, 759	-----
Total, emergency road construction.....	-----	24, 265, 375	-----
Emergency relief loans (Seed Loan Office):			
Loans to farmers in drought and storm stricken areas of the United States.....	-----	-----	\$40, 497, 942
Agricultural credit and rehabilitation loans in drought and storm stricken areas of United States.....	-----	-----	6, 237, 349
Loans to farmers in drought and storm stricken areas of South-eastern States.....	-----	-----	1, 858, 907
Total, emergency relief loans.....	-----	-----	48, 594, 198
Total, emergency expenditures, \$74,050,665.			

¹ These emergency *expenditure* figures should not be confused with the emergency *appropriation* figures given in the body of this report.

² Includes \$513,647 for national-forest improvements other than roads and trails, \$100,000 for control of insect infestations, \$22,340 toward construction of Forest Products Laboratory building, and \$59,345 miscellaneous.

³ Construction of fire-protection roads and trails in national forests.

⁴ Includes \$20,296,266 for advances to States for construction of Federal-aid highways, \$891,524 for highways within national forests, and \$24,969 for public-land highways.

TABLE 4.—*Expenditures classified by types of activity*

Type of activity	General activities		Payments to States	Road construction	Relief loans	Total	
	Amount	Per cent				Amount	Per cent
Research.....	¹ \$17, 472, 529	² 25. 9	³ \$4, 340, 000	-----	-----	\$21, 812, 529	7. 0
Extension.....	2, 671, 542	4. 0	⁴ 8, 672, 936	-----	-----	11, 344, 478	3. 6
Eradication or control of crop and animal pests.....	⁵ 14, 131, 333	20. 9	-----	-----	-----	14, 131, 333	4. 5
Regulatory work.....	⁶ 11, 961, 027	17. 7	-----	-----	-----	11, 961, 027	3. 8
Service activities.....	⁷ 21, 234, 684	31. 5	⁸ 3, 428, 166	-----	⁹ \$49, 519, 006	74, 181, 856	23. 7
Road construction.....	-----	-----	(¹⁰)	¹¹ \$180, 112, 015	-----	180, 112, 015	57. 4
Total.....	¹² 67, 471, 115	100. 0	¹³ 16, 441, 102	180, 112, 015	49, 519, 006	¹⁴ 313, 543, 238	100. 0
Percentage of grand total.....	21. 5	-----	5. 3	57. 4	15. 8	100. 0	-----

¹ Includes \$316,141 paid from emergency appropriations.

² 5.6 per cent of grand total.

³ Payments to State agricultural experiment stations and to Hawaii under Hatch, Adams, and Purnell Acts.

⁴ Payments to State agricultural colleges and to Hawaii and Alaska under Smith-Lever, Capper-Ketcham, and supplemental acts.

⁵ Includes \$4,796,787 paid to livestock owners as Federal indemnities for animals destroyed in connection with tuberculosis eradication, and \$344,486 paid from emergency appropriations.

⁶ Includes \$21,963 paid from emergency appropriations.

⁷ Includes \$569,179 paid from emergency appropriations.

⁸ \$1,618,493 for cooperation with States in forest-fire protection and \$90,798 for cooperation with States in the distribution of forest planting stock under Clarke-McNary Act; and \$1,718,875 for payments to States and Territories from national-forest receipt funds for benefit of county roads and schools.

⁹ \$48,594,198 for loans to farmers in drought and storm stricken areas and for agricultural credit and rehabilitation loans, under special emergency appropriations; and \$841,231 for loans in drought and storm stricken areas and \$83,577 for collection of loans under regular appropriations.

¹⁰ \$155,312,613 paid to State highway departments for Federal-aid roads, included under column "Road construction."

¹¹ Includes \$24,265,375 paid from emergency appropriations. (See tabulation "Payments to States and road expenditures.")

¹² Includes total of \$1,191,092 paid from emergency appropriations.

¹³ See tabulation "Payments to States and road expenditures."

¹⁴ Includes total of \$74,050,665 paid from emergency appropriations.

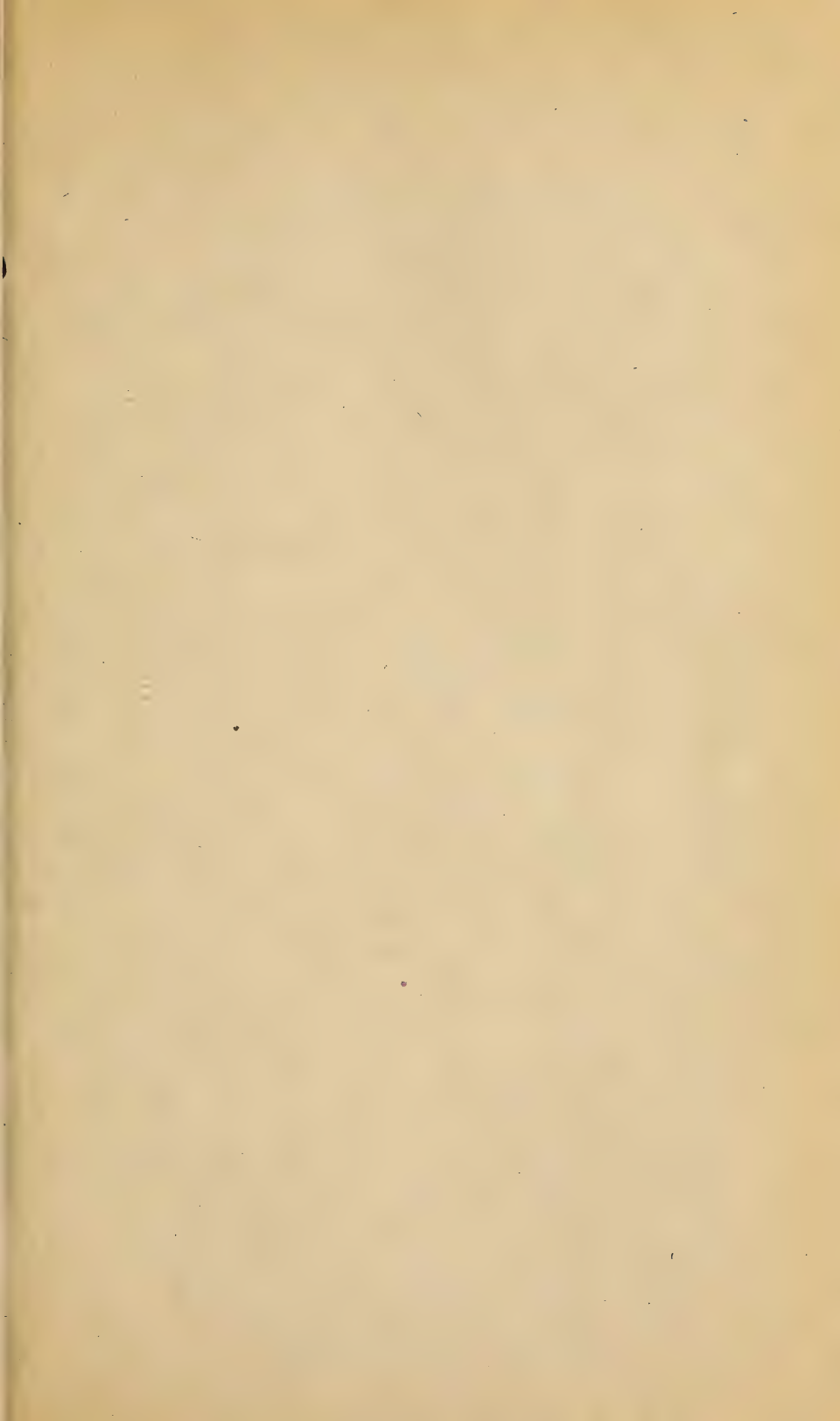
Income From Department's Activities, Fiscal Year 1931

Incident to the department's work during the fiscal year 1931, receipts totaling \$13,129,858 were paid into the Treasury, and fines were imposed and judgments recovered by the courts in connection with the enforcement of regulatory laws amounting to \$98,188, as follows:

Receipts:

(1) Deposited to credit of miscellaneous receipts fund—		
From business on the national forests....	\$4, 993, 320	
Contributions from private cooperators, appropriated as a special fund for road and trail construction, fire prevention and suppression, brush disposal, and investigative work on national-forest and privately owned lands.....	2, 314, 998	
From other sources.....	1, 744, 528	
		\$9, 052, 846
(2) Fees collected for classifying cotton, deposited to credit of revolving fund for conducting that work.....		386, 543
(3) Seed and other loan collections.....		3, 301, 192
(4) Reimbursement to various department appropriations for expenditures made therefrom.....		389, 277
Total receipts.....		13, 129, 858
Fines: Fines imposed and judgments recovered by the courts in connection with violations of statutes intrusted to department for enforcement.....		98, 188
Total income from activities of Department of Agriculture..		13, 228, 046





ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ECONOMICS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF AGRICULTURAL ECONOMICS,
Washington, D. C., October 9, 1931.

SIR: I transmit herewith a report of the work of the Bureau of Agricultural Economics for the fiscal year ended June 30, 1931.

Respectfully,

NILS A. OLSEN,
Chief of Bureau.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

Agriculture has felt this last year the full impact of the world-wide economic depression. Prices for farm products have declined drastically and in some instances have gone below previous bottom prices. Prices of commodities that farmers buy have also declined, but not in a corresponding degree. Taxes, furthermore, have remained at peak levels, and debts have yielded grudgingly in the face of dwindling farm incomes. As the causes of the present situation are many, so are the avenues of solution. It is a situation that calls for far-reaching adjustment in production and marketing, in credit, taxation, land utilization, and in State and National policies affecting agriculture. It is a situation that requires action by the farmer, the business man, and by National and State Governments. Some of these adjustments may be made more or less promptly, others only more gradually.

As a basis for action there must be adequate information for effective planning. The current facts of production, demand, distribution, and the like are indispensable, but much more is needed. The meaning of such facts must be ascertained and used as a guide to action. Much of the farmer's present plight grows out of past failures to understand the trends of the times and to avoid pitfalls. Continuous adjustments in the light of adequate information give promise of materially improving present conditions and of preventing their recurrence.

The activities of this bureau are directed at vital segments of the farm problem. There is scarcely an economic phase of agriculture that is not comprehended in its services and research. Its collection and dissemination of the current facts of production and distribution, its researches in price trends, outlook, farm organization, land utilization, credit, taxation, tariffs, transportation, standardization, de-

mand, marketing, standards of living, and agricultural history, all aim to provide information required by producers, distributors, consumers, and the public generally in formulating farsighted policies and effective programs of action. Its inspection and certification of farm products and its warehousing and regulatory activities facilitate the processes of marketing farm products.

The current fact-collecting services of the bureau have been measurably strengthened at home and abroad. The estimates in the field of crop and livestock production have grown in scope and frequency until now an average of 65,000 separate State and United States estimates covering 91 crops and classes of livestock are issued annually. The expansion in the dairy, fruit, truck, and canning crop estimates has been particularly marked during the year. Special research has led to improvement in the technic of crop and livestock estimating. Considerable progress has been made in reporting the quality of crops as produced. This type of service is perhaps best represented by the cotton grade and staple estimates.

The market news service is no less important as a source of current information on shipments, receipts, prices, market conditions, and other facts required in successful marketing. In the span of 16 years this service has grown until it covers most of the important commodities in 40 central markets of the country and in many important producing areas. The reports are flashed daily over 10,500 miles of leased wire, announced from more than 100 radio stations, and appear in mimeographed and printed reports bulking annually to millions of copies.

This year has witnessed also a material expansion of the bureau's fact-collecting activities in the foreign field. With the financial assistance of the Federal Farm Board and under the legislation recently passed by Congress, the bureau has stationed additional representatives to report on conditions of competition and demand in the Mediterranean Basin, the Balkans, Argentina, South Africa, and Australia, and in other ways has strengthened its reporting work abroad. This expansion of the foreign agricultural service is in growing recognition of the influence that foreign conditions exert upon American agriculture.

Economic research is at the very heart of the bureau's work. It yields the conclusions upon which adjustments affecting agriculture can effectively be made. Increasing support for studies of the influences affecting supply, demand, and price has laid the foundation for the nation-wide outlook service of the bureau. Studies in farm management and organization are uncovering adjustments that may be made on individual farms in various parts of the country to reduce costs and to increase net profits. Land-utilization investigations are gradually providing the basis for more effective handling of submarginal lands. Investigations of taxation, credit, land value, and other economic factors point to needed adjustments in these several fields.

In the realm of marketing a national, and for some commodities an international, inspection and certification service has been built upon the standardization research of the bureau. Studies in the field of consumption and demand have gradually been broadened to provide a better base for orderly marketing. The bureau is also devoting an increasing amount of study to the marketing machinery and

the processes of agricultural marketing in order to discover possibilities of eliminating the losses and waste in distribution.

The standardization and inspection service of the bureau has continued to grow rapidly. The inspection of fruits and vegetables, for example, this year broke all records. An unusually large volume of cotton was classified by representatives of the bureau under the cotton futures act. There was also a marked increase in the activities under the cotton standards act. It is estimated that licensees of the department classed over 2,700,000 bales of cotton. No less striking were the developments in the warehousing field. It is estimated that over 50 per cent of the cotton crop is now handled annually in federally licensed warehouses and that nearly 400,000,000 bushels of grain pass annually through federally licensed grain-handling facilities.

In the regulatory field the most outstanding developments were in connection with the perishable agricultural commodities act passed by the last Congress. More than 1,500 complaints in the handling of fruits and vegetables were received, and of these more than one-half had been closed by the end of the year. A majority of these complaints alleged the unjustifiable rejection of shipments, failure to deliver without reasonable cause, or failure to account promptly. The larger number of the cases have been promptly settled through the intervention of the bureau without the necessity of formal proceedings.

DIVISION OF FARM MANAGEMENT AND COSTS

C. L. HOLMES, in charge

The Division of Farm Management and Costs has continued to study the business side of farming. Applied specifically to the individual farm, the work of the division is concerned with finding those cropping and livestock systems of farming that make the best use of the farmers' resources and pay best in the long run.

TYPES OF FARMING

The purpose of studies in types of farming is to determine what degree of regional specialization exists and what are the underlying forces which have caused groups of farmers to engage in the particular forms of crop and livestock organization. A further purpose is to evaluate the local resources available to the farmers and to analyze the utilization of these by groups of farmers.

In cooperation with the agricultural experiment stations, type-of-farming manuscripts were completed and published for Kansas, Minnesota, Michigan, and Texas. Studies are under way also in Missouri, Wisconsin, and Connecticut. In cooperation with the Iowa Agricultural Experiment Station, a study of the place of pasture in Iowa farming was also made.

FARMERS' RESPONSE TO PRICE CHANGES

Study of the causes which lie behind the changes made by farmers in their production programs and marketing policies was continued. An understanding of these causes is necessary in order to understand the current agricultural-production situation, to outline desirable

systems of farming, to anticipate future supplies, and to measure market prospects.

A manuscript dealing with the factors affecting the flax acreage in the United States and in the four important flax-producing States was published. In this study it was found that farmers may be expected to increase their flax acreage when the actual return from flax, as compared to that from spring wheat at the previous harvest time, and the prospective relative return at the current planting time are high, and a decrease is to be expected when the situation is reversed.

In a study of hog production and marketing it was found that the year-to-year changes in production can be best explained by the relation between prices of corn and hogs of from 6 to 30 months before, that hog weights change from season to season in response to the preceding summer's "corn-hog ratio," the current fall corn supply, and the proportion of the total United States supply marketed from the Corn Belt.

FARM POWER AND EQUIPMENT

Study of the utilization and cost of farm power was continued in cooperation with the Bureaus of Animal Industry and Public Roads and 10 State agricultural experiment stations in the central Corn Belt and Cotton Belt States. A report covering the survey in the Corn Belt States is now being prepared, and a number of the cooperating experiment stations have analyzed and prepared for publication the information for their own States. The Louisiana Agricultural Experiment Station has published a bulletin entitled "An Economic Study of Factors Affecting Farm Organization and Power Utilization of Sugarcane Farms." The Mississippi Agricultural Experiment Station has prepared a manuscript entitled "Farm Power in the Yazoo-Mississippi Delta."

The department issued Technical Bulletin No. 244, *Harvesting Small Grain, Soybeans, and Clover in the Corn Belt with Combines and Binders*. This bulletin compares different harvesting methods and these comparisons should be of value in assisting farmers who are considering the purchase of combines for harvesting.

CORN-HARVESTING METHODS

An analysis of data on methods and costs of harvesting corn was completed and a technical manuscript, giving in detail the quantities of the cost elements used in harvesting corn, has been prepared for publication by the Illinois Agricultural Experiment Station. A manuscript on methods and costs of filling silos and one on husking corn in the field were practically completed for publication in the *Farmers' Bulletin* series by this department.

The growing use of the mechanical corn husker and of the field-silage harvester are examples of the substitution of power and equipment for man labor on farms. An average of 5.44 hours of man labor were used per acre in husking corn by hand on 174 farms during the period 1920-1928. On 102 farms an average of 2.72 hours of man labor was used per acre in husking with 1-row huskers, and on 64 farms on which 2-row machines were used an average of 2.21 hours of man labor were used per acre in 1928 and 1929. Man labor made

up 65 per cent of the total estimated cost of hand husking compared with 25 per cent when machines were used. During these periods the average total cost of husking by hand was about 10.5 cents per bushel; it was 8.3 cents when 1-row huskers were used and 6.6 cents with 2-row machines.

In 1929 the average cost of filling silos with stationary cutters on 47 farms was \$1.29 per ton, where the machines were owned by the operators, and \$1.37 per ton, where custom machines were hired. On 88 farms where field silage harvesters were used the average cost was \$1.22 per ton. While the difference in average cost of filling is not great, smaller crews are required in filling with the field harvester, less total labor is required, and there is less of the hard disagreeable work usually associated with silo filling. The maximum capacity of the field harvester is considerably less than that of the stationary cutter, a limiting factor where several silos are to be filled during a season.

THE APPLE INDUSTRY

Preliminary reports covering the varieties and ages of trees now in commercial and farm orchards in each of 25 States were published and a summary report containing tree statistics for a group of 41 States was issued. Additional field work covering tree statistics for approximately 500 Ohio orchards was completed. The results of this project have proven particularly helpful in determining the outlook for the apple industry and in aiding growers in selecting varieties for their orchards.

A cooperative preliminary report, entitled "A Statistical Study of Apple Shipments from Western New York," was published by Cornell University. This report presents information on domestic and foreign distribution of apples grown in western New York by variety, grade, size, and type of container.

A project on orchard management, conducted in cooperation with the States of Virginia, West Virginia, and Pennsylvania, is in its third and final year. Technical Bulletin No. 234, entitled "Marketing Apples Grown in the Cumberland-Shenandoah Region of Pennsylvania, Virginia, and West Virginia," was prepared in cooperation with the State experiment stations of those States.

THE EASTERN GRAPE SITUATION

An economic study of the eastern grape situation was continued in cooperation with the agricultural experiment stations of Arkansas, New York, Michigan, and Pennsylvania. A bulletin, entitled "Growing and Marketing Grapes in Erie County, Pa.," was published in cooperation with the Pennsylvania State College of Agriculture. This publication points out that lake-plain vineyards had fewer missing vines per acre and produced better yields than did the vineyards on the hill farms; also that, as a rule, when the yield was below the average there was little left as wages for the farmer after all expenses were paid. On the small farms it was cheaper to do the work with horses; on the average farm of over 50 crop acres it paid to use a tractor. Forty-six per cent of the grapes were transported from the farm by truck, and truck shipments realized

the highest prices. These small farms contain, on the average, about 50 crop acres, and of this acreage almost one-half was in grapes. The investment per acre is relatively large, and, as pointed out in the bulletin, efficient methods of production are much to be desired in times like the present, when grape prices are low.

RETURNS TO STRAWBERRY GROWERS

A study of the commercial strawberry industry of 11 Southern and Eastern States was continued in cooperation with their agricultural colleges and experiment stations. A manuscript dealing with production practices, costs, returns, marketing, distribution, and prices was prepared for publication as a technical bulletin.

The report shows that the strawberry acreage in the early-shipping States has increased greatly during the past decade and points out that further increases in these States are to be expected. Although early States have relatively high production and marketing costs as compared to other producing States, prices have been relatively well maintained in the face of increased production. The increased production of the early States has adversely affected the demand for strawberries from the second-early and intermediate States. However, with the possibility of a continuation of marketing costs at present levels and with lower wages and increased labor supplies, a considerable increase in the late-marketing States of the eastern group is to be expected. The results indicate that the important second-early and intermediate States have similar costs of production and that it would be advantageous to growers in different States to adapt their production programs to the demands of certain markets.

THE PECAN INDUSTRY

A cooperative study of the economic aspects of the pecan industry was completed, and a manuscript prepared for publication giving a detailed analysis of both present production and probable future production, of marketing practices and problems, and of production costs and returns.

Particular attention was given to determining the reasons for success or failure in the development and management of pecan orchards. This phase of the study shows that many pecan growers have not obtained profitable returns for the outlay of capital, labor, and use of land required by the enterprise, while others have had consistently good returns over a period of several years. Several factors are responsible, either singly or in combination, for the unprofitable returns from many pecan orchards. Planting unsuitable varieties and locating the orchards in soil which can not meet, or be made to meet economically, the plant-food requirements of pecan trees has resulted in many unprofitable orchards. Other factors which have contributed to low returns are planting pecan trees at intervals so close that the growth of the individual trees did not result in a normal, well-developed orchard, neglecting to control insect pests and fungous disease, and failing to follow well-planned systems of cultivation and soil upbuilding. The profitable yields obtained on the better managed orchards are proof of the possibilities of a well-planned system of pecan-orchard management.

BROOMCORN PRODUCTION

An economic and agronomic study of the broomcorn industry, carried on in cooperation with the Bureau of Plant Industry and the experiment stations of the States of Illinois and Kansas, was completed. A farmers' bulletin dealing with the production and handling of broomcorn was published, and another manuscript giving a detailed analysis of the results of the study was prepared for publication as a technical bulletin. These manuscripts show methods and costs of producing and handling broomcorn, give suggestions for improving methods, and set forth the economic place of broomcorn and the major competing cash crop in each of the important districts, as determined by natural conditions and different price relationships.

EARLY-POTATO FARMING IN VIRGINIA

The field work of a three years' study in the early-potato-producing sections of eastern Virginia was completed in cooperation with the Virginia Polytechnic Institute and the Division of Agricultural Finance of this bureau. This study aimed to provide a basis upon which early-potato producers may organize their farms for the most economical production and maximum net returns, and to determine the farmers' need for credit and the degree to which it is being met.

The very low price received for the 1928 early-potato crop of the area focused attention upon an old and permanent problem of adjustment. Thus far the farm-management phase of the study indicates that the general problem of the area is largely one of adjusting production to demand and of efficiency in potato production. A liberal expansion in producing food products for home consumption and feed for livestock would be in the right direction, one year with another. Although individual farmers may have limited opportunity for commercial expansion in production of truck crops, poultry, hogs, and dairy, there does not seem to be opportunity for the expansion of such enterprises to any large extent.

COTTON, PEANUT, AND HOG FARMING IN GEORGIA AND ALABAMA

An analysis of the farming problem in the peanut area of southeastern Alabama and southwestern Georgia was completed in cooperation with the agricultural experiment stations of Georgia and Alabama.

In this analysis the plow unit was taken as a measure of the size of the farm, since the usual cropper farmer operates one of these units. It was shown that the income from a single plow is insufficient to maintain a desirable standard of living. A 1-plow farm owner-operator may be in somewhat better circumstances than the cropper, since he may diversify his production to a greater extent and also farm more intensively. The relationship of the size of farm to the various enterprises of the farm organization was shown from the standpoint of production, income, expenses, and net results.

In general it was shown that production of hogs in the area is not systematic. Very little control is exercised over breeding operations; therefore pigs are being farrowed almost steadily throughout

the year without proper regard for the time of marketing, seasonal prices, or feed supplies. Effort will be made to furnish to the producers information on the general situation of the hog industry which will give them a basis for appraising the short-time outlook for hog prices and assist them in determining whether to market hogs early or late in the season. In this connection many hogs were found to be very light in weight at the end of the peanut-grazing season because an insufficient acreage of peanuts was reserved for their fattening. Standards were presented that will enable a grower to estimate more accurately the acreage needed to fatten a given number of hogs.

INFLUENCE OF WINTER LEGUMES ON CROP PRODUCTION

In cooperation with the Bureau of Plant Industry, a study of the use of winter legumes in farming systems of North Carolina, South Carolina, Georgia, and Alabama was continued. The data obtained show that the practice of plowing under winter legumes as fertilizers for cotton, corn, and other crops is, on the average, profitable. On the farms studied the yield of corn was increased from an average of 20 bushels per acre to 34 bushels by this practice, and that of cotton from 281 pounds of lint per acre to 381 pounds.

The net gain from the use of winter legumes as a fertilizer for corn was \$9.09 an acre, all costs considered, or \$11.76 an acre when only cash costs are considered, corn being valued at \$1 a bushel. Should the price of corn fall to 50 cents a bushel, the net gain would be \$2.09 per acre, all costs considered, or \$4.76 an acre with only cash costs considered. Relatively good net gains were obtained from the use of winter legumes turned under for cotton.

The critical factors in the profitable use of winter legumes are a good stand and growth of the legumes and a good stand of cotton, corn, etc., following the legumes. Information will be published which will be helpful to farmers in meeting these conditions.

ORGANIZATION AND MANAGEMENT OF COTTON FARMS

In cooperation with the Arkansas Agricultural Experiment Station, study was continued for the purpose of determining improvements in the organization and management of cotton plantations.

The agriculture of the piney woods farming area of Texas is representative of that in extensive areas in the Cotton Belt in which the natural conditions of climate, soils, and topography are fairly similar. Family farms predominate in the area, with cotton the leading, and in many cases the only, cash crop. A study was undertaken in cooperation with the Texas Agricultural Experiment Station to determine the commercial enterprises which could be profitably included in the farm organization to supplement the income from cotton and thus lessen the financial difficulties often caused by low cotton yields or prices.

EUROPEAN CORN BORER

A study to determine the most successful systems of farm organization and operation under corn-borer conditions is being continued in cooperation with the Indiana Agricultural Experiment Station

and the Michigan State College of Agriculture. In anticipation of the demands for information on changes in crop rotations, live-stock combinations, farm practices, and more effective equipment in existing farm organizations incident to the possible further westward movement of the European corn borer, a study has been inaugurated in the intensive corn-producing sections of northwestern Missouri.

An analysis of the possibilities of substituting other crops for corn in the Corn Belt indicates the definite impossibility of substituting cash crops for corn to any extent without seriously disturbing price relations and lowering farm incomes. Control measures can be added to the present farm operations at a cost that is small compared to the loss that may result if no control is attempted or if the growing of corn is discontinued. Although additional labor and expense are not needed until a serious infestation threatens, early consideration of a definite control program is advisable on each individual farm to avoid serious disturbances of the farm organization when the necessity for such a change arises.

SWEETCLOVER IN THE GREAT PLAINS

During the year an economic study of sweetclover on farms in the Great Plains area was undertaken in cooperation with the Bureau of Plant Industry. Records of utilization practices, cost of seeding, carrying capacity of sweetclover pasture, and increased yields of crops following sweetclover were obtained from farmers in nine States. Information will be published on the feed and fertilizer value of this crop.

ORGANIZATION AND MANAGEMENT OF WHEAT FARMS

Studies have been carried on in cooperation with the agricultural experiment stations in Kansas, Minnesota, Oklahoma, North Dakota, and South Dakota, covering various sections in these States, for the purpose of working out the most profitable combination of crops and livestock. Particular attention is being given to aiding farmers in establishing a more diversified system on lands which were formerly devoted entirely to wheat. Definite information is being gathered on the size of farm needed for profitable operation and the most economical types of power and equipment.

FARM-ORGANIZATION STUDIES IN KENTUCKY, VIRGINIA, AND TENNESSEE

A study involving the organization and operation of farms of greater than ordinary size was undertaken in connection with the agricultural experiment station of Kentucky. It is already evident that the analysis of the data gained in this study will be of major assistance in determining the conditions and the form of organization and operation under which such ventures are likely to be permanent and successful.

A project in the tobacco section of south-central Virginia looking toward the development of better systems of farming was continued in cooperation with the Virginia Polytechnic Institute. Largely because of the severe drought in 1930, the financial results on the farms surveyed in that year were much lower than during

preceding years, but they were encouraging when compared with those from other farms where changes in the farming systems have not been made during recent years.

In Tennessee the project relating to farm account books was continued in cooperation with the agricultural experiment station. During the year over 200 books were summarized and the results placed in the hands of farmers with interpretations of the outstanding reasons for success or failure in the year's operation.

TRUCK-CROP FARMING IN NEW JERSEY

During the past few years a number of farmers in the potato and truck crop areas of New Jersey have done practically all of their field work with tractors. In cooperation with the New Jersey Agricultural Experiment Station, detailed financial, feed, and labor records were started on approximately 40 motorized farms and 40 horse farms in order to determine the conditions under which each source of power may be used to best advantage.

LIVESTOCK FARMING IN OKLAHOMA

Mayes and Craig Counties, in northeast Oklahoma, are devoted mainly to the production of feed which is marketed or fed to livestock. In cooperation with the Oklahoma Agricultural Experiment Station, a project was started in these counties on the various systems of farming followed, with the object of determining the choice and combination of enterprises most profitable in view of the natural and economic conditions prevailing in the area.

RANGE-LIVESTOCK PRODUCTION

Studies of range cattle and sheep production and of ranch organization were continued in each of the important range-livestock-producing districts. These studies were carried on in cooperation with the Bureau of Animal Industry and with State agencies, and emphasized economical methods of production and ranch organization. Much of the information collected was placed before ranchmen in special meetings held for the purpose and in the form of printed reports. Publications were issued covering ranch management and organization in the Edwards plateau of Texas and in North Dakota and South Dakota. Work was continued in Montana and in the North Park and Saratoga Valley districts of Colorado and Wyoming. Special attention is being given to factors affecting range sheep and wool, and mohair production in Arizona and New Mexico.

ORGANIZATION AND MANAGEMENT OF DAIRY FARMS

A survey of 329 farms in 5 dairy areas in northern New Jersey was completed in cooperation with the New Jersey Agricultural Experiment Station. It was found that conditions under which it was more profitable to buy cows for dairy replacement than to raise them depend upon the contacts that have been established by dairymen and upon their skill as breeders.

Marked variations were found between farms and between areas in the quantities of concentrates used per 100 pounds of milk sold.

In one section, where many of the concentrates are home grown, 66 pounds of total concentrates were used per 100 pounds of milk, while in another section, where practically all of the concentrates are purchased, 43 pounds were used per 100 pounds of milk. Lack of balance in the rations was responsible for the waste of feed in the first area.

A manuscript is in preparation growing out of a 3-year study, made in cooperation with the Minnesota Agricultural Experiment Station, of the dairy region of northeastern Minnesota as represented by the group of farmers at Askov, in Pine County. It will discuss the elements involved in the organization and operation of small farms in the cut-over region, the practices of the local farmers, and the quantities of the cost elements used in production.

POULTRY FARMING

The study of the place of poultry in the organization of Utah farms was continued, and a bulletin was published by the Utah Agricultural Experiment Station setting forth various economic factors affecting the production and marketing of poultry products in Utah.

Plans were made for undertaking, in cooperation with State agencies, a study of the poultry industry which will be national in scope and will cover various economic phases of production, inter-regional competition, and movement and storage in relation to financial returns to poultrymen in various areas. It is proposed to utilize existing material wherever it is available and to make new surveys in areas for which such information is lacking.

SUMMARIES FROM FARM-BUSINESS STUDIES

Results from farm-business studies made by this bureau and by State agricultural experiment stations and colleges, covering 30,191 farm records from 336 localities in 25 States, were summarized and published in the 1931 Yearbook of Agriculture. This compilation shows for each farm the type of farming, average acreage, capital, expenses, and such forms of income as receipts, farm income, labor income, returns on capital, family living from the farm, and operator's earnings.

COST OF PRODUCING STAPLE CROPS

Cost-of-production figures for corn, wheat, oats, and cotton were published for the year 1930. Owing to the very low corn yields in 1930, the average cost of producing the 1930 corn crop on 3,616 farms was 89 cents per bushel, which was 16 cents higher than the cost in 1929. Corn yields reported by these farmers averaged 31 bushels per acre in 1929 and 23 bushels in 1930. Wheat yields in 1930 were generally reported as higher than in 1929, and the average 1930 cost reported by 2,334 farmers was \$1.09 per bushel, which was 15 cents per bushel lower than during the previous year. Wheat yields on these farms averaged 17 bushels in 1929 and 18 bushels in 1930. For oats the average 1930 cost reported by 2,526 farmers was 50 cents per bushel, which was 4 cents lower than the average cost reported in 1929. Oat yields reported by these farmers averaged 33 bushels per acre in 1929 and 34 bushels in 1930.

Cotton costs reported by 1,028 farmers were tabulated by yield groups, since many of the farmers reporting had yields that were much above the average. On 285 of these farms yields ranged from 101 to 180 pounds per acre and averaged 145 pounds. For this group the average cost was about 16 cents per pound. On the lower-yielding farms costs were higher, and on the higher-yielding farms costs were lower.

FARM RETURNS

Farm owners reported the financial results of farm operation in 1930, which was a difficult year for farmers because of drought and low prices. The averages of reports from 6,228 farmers show receipts from sales amounting to \$2,211, cash outlay for current operations amounting to \$1,452, leaving a cash balance of \$759; but a decrease of \$221 in inventory value of crops, livestock, and machinery and supplies was sustained, so that the net result thus defined was \$538. Other factors less completely or generally reported modify this figure.

The average value of food produced on the farm and used by the family was \$242. Interest paid on debts took \$199 (more on the farms paying interest) and on the average \$92 was spent for improvement of real estate. The value of the family labor not paid wages was estimated to be \$716 on the same basis as the \$378 paid to hired labor. Decrease in value of farm real estate amounted to \$757, or 6.3 per cent.

The average size of the farms for which results were summarized was 284 acres, worth at the beginning of the year \$12,009. The average value of personal property was \$3,156 per farm. These descriptions exceed census averages, partly because the farmers reporting are above the average of their localities, but more especially because few reports are received from farms smaller than 50 acres.

The average net result for 1930 of \$538 was only 41 per cent as large as the average (\$1,298) for the similar group of 11,805 farmers reporting for 1929. Receipts declined more than expenses, and reporting farmers were in poorer financial condition at the end of 1930 than they were at the beginning of the year.

CROP AND LIVESTOCK ESTIMATES

W. F. CALLANDER, in charge

DROUGHT SURVEYS

The severe drought which prevailed over a large portion of the country in 1930, causing widespread damage to crops, introduced many new and perplexing problems in crop estimating, and brought greatly increased demands for information on farm conditions during the drought period and subsequently. The bureau was able to respond to these demands because in the ordinary conduct of its crop-reporting work it maintains a close relationship with hundreds of thousands of farmers throughout the United States who are accustomed to furnishing information for their localities and for their own farms. When the drought situation first became acute, the Division of Crop and Livestock Estimates made an analysis of its current monthly information and called attention to the short corn crop and the resulting maldistribution of feed supplies for live-

stock. Food supplies for human beings, generally speaking, were found to be plentiful, but there was a serious corn shortage in areas where large quantities of home-produced and shipped-in livestock are fed. The regular crop report as of August 1 was published in much greater detail and was given much more widespread publicity than usual in order to disseminate the fullest possible information concerning the areas affected by the drought.

In order that the national drought committee and the State relief committees might have more detailed information with respect to the areas in which the situation might be expected to become critical, the first drought survey, as of August 20, was made. From the results of this inquiry it was possible to ascertain the supply of old-crop grain and hay on hand and the prospective production of the current year's crop in relation to livestock numbers on the same farms. These data provided a uniform standard for measuring the excess or deficiency of livestock feed.

When the American Railway Association made arrangements for a reduction in freight rates on livestock shipped out of deficient-feed areas and on feed shipped into these same areas, this bureau had available information which was of assistance in determining the counties in which these tariffs should be effective.

By November 1 it was apparent that additional facts regarding the rôle wheat would play as a substitute feed for corn and other feed grains were needed. A wheat survey was made, therefore, which disclosed that consumption of wheat for livestock feed would be more than double that of the preceding year. It disclosed also the parts of the country in which shifts in the feeding of wheat were more general and more pronounced.

CROP FORECASTS

Much progress was made in improving the basis of the monthly forecasts of crop production. In many instances the results of studies of the relationship of weather to yields were incorporated in the crop-forecast program. This was accomplished either by utilizing separately determined indications of yield from the weather reports as an additional indication to that obtained from the condition reports, or by utilizing a combined indication derived from a graphic multiple correlation of the two sources (weather and condition).

COTTON REPORTS

An extensive program of research in cotton estimating was drawn up early in the year and included the following: (1) Revision of yield and acreage estimates from 1919 to 1929; (2) retabulation of a number of reported items used as a basis for estimating acreage and yield, in which reports from the field and Washington lists were to be combined by districts; (3) the compilation of weather data, comprising a large number of the recorded items from selected stations; and (4) the preparation of numerous relationship studies using the retabulated reported items and weather data as indications of acreage and yield.

The tentative revisions of acreage and yield, which, by improving the comparability between years, increased the reliability of the

series as a basis for relationship studies, have been completed. Re-tabulation of selected items of reported data is practically completed. For a number of items this has resulted in marked improvement in the stability of State averages. The most essential items of weather data have been compiled, thereby practically completing that part of the program dealing with the preparation of basic material.

Using the revised data outlined above and supplemental material, over 500 relationship studies relating to acreage, yield, and production were prepared by this office during the past year. The acreage studies were designed to give a more definite and precise picture of the relationship between reported individual farm acreage changes and actual acreage changes in individual States. The studies of reported condition and probable weevil damage as related to final yields were refined. The use of relative advancement of ginnings on October 1, November 1, and December 1 as a statistical measure of the bias present in crop correspondents' estimates of probable yield per acre and probable county ginnings was inaugurated in 1930. This analysis should add to the precision of these indications of production. Other studies that were used related to the number of bolls per plant and to yields, sample data and bale weights, abandonment of acreage, fertilizer sales as related to acreage, indication of the percentage of the crop ginned to various dates, etc. These studies were used by the Crop Reporting Board as a basis of interpreting "raw" data into terms of acreage, probable yield, and production of cotton in the preparation of about 500 estimates incorporated in seven regular cotton releases.

Progress was made in perfecting studies of the effect of weather on cotton yields, three members of the field staff being called to Washington to assist in the studies. Satisfactory multiple relationships have been established in seven South Atlantic and Gulf States, and these studies will be used this season for the first time as indications of probable weevil activities and of probable yield per acre. Results to date have been very promising, and the studies will be continued with the objective of establishing similarly satisfactory relationships for all cotton-producing States. As a result of refinement of method, the cotton forecasts for the last few years have been remarkably close to the final ginnings, and their accuracy has been widely and favorably commented upon.

FRUIT, TRUCK, AND CANNING CROP REPORTS

The increased attention that the field force has been able to give to fruit, truck, and canning crops and the improvement made in the presentation of compiled material have made the reports on these crops much more useful. This is evidenced by the rapidly expanding demand for these data and the many letters of commendation received from the fruit and vegetable interests. Practically the entire series of reports already established on the various fruits and vegetables has been continued and new series of estimates on additional crops have been started whenever sufficient basic data could be assembled. In the past year, estimates were issued for the first time on Lima beans and beets, both for market and canning, on kale, peppermint, and horseradish. Information is now issued in the form of commodity reports, each containing all the currently

available estimates and notes on some one crop. The change from the former type of report has increased the usefulness of the statistics and permits limitation of mailing to persons who are certain to be interested.

The new series of reports on fruit and potato prospects has been well received. It has been found especially useful by growers' associations and by various fruit publications and other periodicals. One fruit publication has considered the material of such value to its readers that it has reprinted in full practically every monthly fruit-prospect report thus far issued.

A new method of tabulating and summarizing the reports furnished by canning establishments has been adopted and gives a more satisfactory running record of a canner's operations on each crop. The attempts to improve the reports have brought a gratifying response from canners. At least 60 per cent of the canning acreage of any crop is represented in the data on which estimates are based and frequently the proportion is much higher. Many calls have been made upon the statisticians in this unit to attend meetings of vegetable growers and canners to discuss the reports.

DAIRY REPORTS

The regular monthly statistical reports have been expanded to include milk estimates. While the work has not progressed far enough to permit the monthly milk production to be estimated currently in pounds, rapid progress has been made in determining the month-to-month changes in production and in measuring the factors responsible for these changes. A beginning has also been made in forecasting the probable trend of milk production several months ahead.

The dairy service is planned primarily to meet the needs of the 5,000,000 farmers who milk cows. It is founded on the belief that these men, if kept currently informed of the number of heifers being raised and of the plans of other producers in regard to increasing or decreasing their herds, will tend to so adjust their plans as to avoid both shortages of supply and troublesome surpluses, except in so far as these may result from weather conditions or changes in demand which can not be foreseen.

To obtain the necessary information on current production of milk and prospects for future production, the cooperation of about 15,000 dairy farmers has been secured. These dairy correspondents report on the first day of each month the numbers of milk cows on their individual farms, the number being milked, the pounds or gallons of milk obtained each day the quantity of grain being fed to milk cows, and the percentage of feed being obtained from pastures. They also report quarterly or semiannually the numbers of cows freshening each month, the numbers of heifers being raised, plans for increasing or decreasing the numbers of cows to be kept on their farms, utilization of the milk produced, the prices received for the dairy products sold, and much detailed information on special angles of the dairy problem. This information is supplemented by the monthly reports from more than 20,000 crop correspondents and by the similar records for about 130,000 farms collected twice a year by rural mail carriers.

All of the information obtained from all parts of the country is now being summarized in a new monthly publication entitled "Milk Production Trends," which is prepared primarily for distribution to the dairy farmers who cooperate with the department. A mimeographed statistical supplement to this report is issued monthly for the benefit of those who wish to have more detailed data for analysis.

CHICKEN AND EGG PRODUCTION REPORTS

A study on numbers of chickens and on production of chickens and eggs in the United States for each census year since 1879, based upon reports of the Bureau of the Census, has been completed and published. Other studies have dealt with consumption on farms, farm sales, shipments, with receipts and consumption at principal cities during recent years, and with much other original data relating to the poultry industry. Data received on the 1st of each month for 20,000 to 25,000 farm flocks belonging to crop reporters are being published monthly. While these sample flocks give an indication of the trend of numbers and production, special studies, and records for commercial flocks will be necessary for a true picture of trends in the poultry industry as a whole.

Reports on numbers of young chickens in farm flocks on the first days of April, May, June, July, and October have reflected the changes in the annual supply of poultry. Similar reports in October, December, and January, on numbers of pullets being saved for layers indicate the prospective supply of eggs. Consideration of these reports permits producers to modify their plans, if they desire, by marketing a greater or smaller proportion of these potential layers or by more or less drastic culling of hens.

LIVESTOCK REPORTS

Special effort has been made to obtain larger and more representative sample returns on livestock in the Western States. Reports from sheep producers in these States have been particularly good, the number of sheep tabulated for the January 1 estimates of numbers being over 10 per cent of the estimated number in these States. Most of the State offices now have very complete lists of sheepmen and have been able to classify these by size of flocks, which gives a much better basis for weighting returns when size of flock is an important factor in determining results.

The census data on all species of livestock on farms April 1, 1930, have been received and will be used as a basis for checking the present estimates of numbers on farms January 1. In order to get additional information on changes in livestock numbers between January 1 and April 1, an inquiry identical with the census schedule was sent in April, 1930, to a large number of farmers who had reported the number of livestock on their farms about January 1, 1930.

It is planned to have this work completed so that the livestock report for January 1, 1932, will show whatever revisions have been made in the estimates of January 1, 1930, and preceding years, as a result of the census for all species except, possibly, sheep. It is not anticipated, however, that these revisions will make any significant change in any of the present estimates for the United States or for the various regions.

FARM-PRICE REPORTS

The past year has been one of the most active in the history of the farm-price section. Prices of agricultural products declined throughout the entire period, and as this decline progressed public and private agencies showed a corresponding increase in their interest in farm prices.

In an effort to facilitate the handling of the many requests received, the work of preparing the price data of the past five years, by States, for publication in bulletin form has been started. It is intended to include in this publication monthly averages of farm prices by geographic divisions, the weighted crop-year averages of prices of farm products, and crop-reporting-district averages of the prices paid to producers for agricultural commodities produced in 1929. Averages of farm prices have been in great demand for outlook work, especially since adoption of the practice of conducting annual regional-outlook conferences. Crop-year averages for farm prices have been extensively utilized for a number of years in the computation of farm-income estimates. Crop-reporting-district averages of prices received by producers for agricultural products have been found of great value where reliable price data for units smaller than States are desired. This latter group of data was assembled in cooperation with the Bureau of the Census for the purpose of establishing county price estimates with which the 1930 enumerations of agricultural production could be evaluated.

A special inquiry on prices of forest products sold from farms in 1929 was also made by the Census Bureau with the assistance of this office. This inquiry was much more extensive than any other ever attempted on a subject of this nature, average prices received by producers for the 1929 cut of saw logs, veneer logs, poles, piling, pulpwood, firewood, railroad ties, mine ties, and fence posts being estimated by crop-reporting districts. These estimates were compiled on the basis of information obtained from the special price reporters of the bureau, from telephone, railroad, electric light and power companies, mine operators, and pulp and paper mills. Records of the Forest Service and the Interstate Commerce Commission proved of great help in checking the returns from these sources.

In addition to the projects mentioned above, the regular routine work of preparing and issuing monthly reports on prices paid to farmers for 45 commodities, quarterly reports on retail prices of 170 articles that farmers buy, monthly summaries of wholesale prices of miscellaneous products, quarterly reports on wages paid to hired farm labor, on the supply of farm labor and the demand for it, and the number of persons employed on farms, and, finally, the special news letter for United States price reporters was carried on as usual.

DIVISION OF COTTON MARKETING

A. W. PALMER, in charge

Because of the extremely low level of cotton prices, with the attendant distress among the 2,000,000 farm families dependent upon cotton production, all the facilities of the cotton division have been used in the general effort to help relieve the strained economic conditions. Work has been speeded up in all sections in order to meet

the increased demands for service and to furnish information needed in working out adjustments.

ENFORCEMENT OF THE UNITED STATES COTTON FUTURES ACT AND UNITED STATES COTTON STANDARDS ACT

The activities under these two acts were particularly heavy. There was a greatly increased demand for the services of the cotton classers of this bureau in classifying cotton delivered on futures contracts, and also a demand for licensed classers by growers who wished to have their cotton classed before its sale.

The fourth international conference met in Washington in May for the purpose of approving sets of the official cotton standards. This conference was attended by representatives from the cotton associations of Belgium, England, France, Germany, the Netherlands, Italy, and Spain, and by an unofficial observer from Japan, as well as by representatives from all the leading associations and exchanges of the United States.

CLASSIFICATION OF COTTON UNDER THE UNITED STATES COTTON FUTURES ACT

Section 5 of the cotton futures act requires that all cotton intended for delivery on futures contracts shall be classified by officers of the department. Boards of cotton examiners are located at New York, New Orleans, Norfolk, Charleston, Savannah, Houston, and Galveston, and an appeal board of review examiners at Washington, D. C. The cotton submitted for certification at Mobile, Ala., was classified by the board of cotton examiners at New Orleans, La.

The outstanding feature of the work this year has been the very large volume of classification and certification, which totaled 896,896 bales. The volume of work handled by the various boards of cotton examiners greatly exceeded that of any year, except the fiscal year 1930, since the passage of this statute. On March 13, 1931, the classification fee was lowered from 30 cents to 25 cents per bale.

CLASSIFICATION OF COTTON UNDER THE UNITED STATES COTTON STANDARDS ACT

Section 4 of the cotton standards act provides that any person who has custody of or a financial interest in any cotton may submit samples to the Department of Agriculture for classification. The various boards of cotton examiners of the bureau are authorized to perform this service in addition to the classification service under the cotton futures act. A total of 28,533 bales was classified under the cotton standards act.

In the last agricultural appropriation act an item of \$75,000 was included to provide additional facilities for supervising licensed classifiers under the cotton standards act. These funds will make it possible to add a number of experts to the staff and to provide a more thorough supervision of licensed classifiers than has been possible heretofore.

LICENSING OF COTTON CLASSIFIERS

During the year the licensing work has assumed greater importance than ever before, because the various cotton cooperative associations employed the services of licensed classifiers to a large extent. At the close of the fiscal year an increasing interest was still in evidence throughout the South.

A total of 327 applicants for licenses were examined and 248 licenses were issued. The importance of this work is shown by the fact that these licensed classifiers classed more than 2,700,000 bales of cotton under the supervision of this bureau.

COTTON MARKET NEWS AND QUOTATIONS SERVICE

The demand for market news service on cotton showed a further increase. Telegraphic reports were received each week from many domestic cotton centers, and weekly cable reports from other large cotton centers in France, Germany, England, and Italy. These reports contained information on the state of demand for various grades and staples of cotton, grade differences, qualities sought and in supply, basis prices, staple premiums, fixations, and other pertinent cotton-marketing information. These data were consolidated in a weekly review, which was telegraphed to field offices and representatives, to be mimeographed and mailed each Saturday to reach every part of the Cotton Belt by Monday morning.

In addition to the cotton market review there was prepared at each of the field offices a premium-staple cotton report which covered the prevailing premiums for cotton staples above $\frac{7}{8}$ of an inch, including the lengths from $1\frac{1}{8}$ to $1\frac{5}{16}$ inches. Certain material covering discounts at certain central markets was also issued in these reports.

Newspapers and periodicals continued especially active in publishing the information assembled, and their facilities for prompt and rapid dissemination were utilized wherever possible. Contact was made during the season with a number of additional rural news organs and resulted in increased dissemination. The circulation of the newspapers and periodicals that carried the cotton market news service reports is estimated to be about 6,500,000. Much of this information was also broadcast by radio stations.

SPOT-MARKET SUPERVISION

To insure that quotations in designated spot markets accurately reflected prices at which cotton is actually sold, visits to the designated spot markets were continued regularly each month, sales of actual cotton examined, and meetings held with the quotation committees of the respective exchanges. Under arrangement with the New Orleans Cotton Exchange, the official basis and difference quotations for that market were determined by the board of cotton examiners at that point.

During the year cotton prices reached lower levels than at any time since August, 1915, and very careful attention was directed to differences between grades for both the tenderable and untenderable cotton and to the quotations for the tenderable grades in the lengths $1\frac{1}{8}$ and 1 inch staple, which lengths command a premium over $\frac{7}{8}$ inch when delivered on futures contracts.

GRADE AND STAPLE ESTIMATES—CROP AND CARRY-OVER

The law directs the Secretary of Agriculture to publish an estimate of the grade, staple length, and tenderability of cotton carried over on August 1, and not less than three such estimates of the growing crop.

Owing to the fact that different qualities of cotton are put to different uses, it is important to both the trade and the producer that the number of bales of each quality produced be known. This is as fundamentally important as to know the total number of bales. The statistics collected under the act providing for the estimates of grade, staple, and tenderability of cotton make it possible to show what qualities of cotton remain on hand at the end of the cotton year, as well as how the quality of American cotton compares from year to year with previous crops.

In order to be of the greatest service to producers of cotton, reports on individual States and subdivisions of the States have been prepared. These detailed reports serve as a basis on which intelligent production programs can be based and are much in demand by cooperative and extension workers. The bureau has continued to furnish a detailed report to each cooperating ginner showing the number of bales of each grade and staple ginned at his gin. These reports serve as a basis for intelligent community planting.

GRADE AND STAPLE ESTIMATES OF CONSUMPTION

Grade and staple estimates of consumption furnish the producers with statistics which show the kinds of cotton which are most sought for by American spinners, and thus afford a guide as to what kinds of cotton should be grown to meet the American requirements and also to replace foreign cottons in North America. Since the United States textile industry is the largest individual consumer of American cotton, facts of this nature are especially valuable at this time when new textile fibers and improved processes of manufacture are being developed and when the spinning industry is endeavoring to find ways and means of cutting manufacturing costs.

The increased consumption of Indian cotton in the United States during the cotton year ended July 31, 1930, was caused by the combination of the low rate of exchange and the low price of cotton in that country. The increased amount of Indian cotton coming here seemed to be in competition with waste products rather than with straight American cotton. Ordinarily the greater part of Indian and Chinese cotton coming into this country goes into specialized use in the blanket and woolen industries.

COTTON UTILITY AND STANDARDS RESEARCH

In the many recent efforts to improve cotton-marketing methods and to solve cotton-marketing problems, much emphasis has been given to the importance of recognizing and rewarding quality.

In its efforts to perfect methods of determining quality in cotton fibers; to develop standards possessing the greatest possible accuracy, stability, and usefulness; to lay a foundation for better gin management and technic; and to contribute to the improvement of the quality of American-grown cotton the bureau is developing a program composed of three closely related lines of investigation, namely, fiber, ginning, and spinning studies.

FIBER STUDIES

The fiber studies embrace a scientific measurement of fiber characteristics and properties.

During the past year the laboratory has completed fiber-length arrays on the 1929 staple-length series, the 1926 series, and the 1918 series. Data from these tests are now being statistically analyzed as a basis for establishing the relationship between bales of a given staple length and of different staple lengths from which specifications for staple length may be drawn.

Supplementing these studies, investigations of the changes in the distribution of fiber lengths during the course of manufacturing processes are being made. The results of these investigations will serve as a basis for determining the accuracy of spinning as a medium of translating fiber lengths and for establishing a technological basis for staple standards.

The microanalytical studies during the past year, in cooperation with the Boyce Thompson Institute for Plant Research and with Clemson College, have brought results which indicate a definite relationship between the structural characteristics of the fibers and their reactions to humidity.

This work is of such a highly technical nature that no attempt will be made in this report to set forth the results obtained. These will be published from time to time in technical bulletins.

SPINNING STUDIES

In cooperation with the textile department, Clemson College, spinning studies have been made on a limited number of cottons grown under natural and irrigated conditions. Special effort has been made in the spinning work to develop technic and methods and to determine the full potential spinnability of cottons specially selected for extremes in certain fiber characteristics.

In cooperation with the Bureau of Plant Industry and a commercial mill, special spinning studies are being made with very long staple cottons in an effort to understand better the comparability of sea-island, Pima, Egyptian, and Sakellarides cottons.

GINNING STUDIES

Under act of April 19, 1930, Congress gave the Department of Agriculture authority to conduct investigations of cotton ginning. The Bureau of Public Roads was assigned the task of constructing, equipping, and operating the ginning plant, and this bureau was assigned the responsibility for laboratory analyses of the samples obtained during the investigations.

The ginning laboratory is located at Stoneville, Miss., and the two bureaus are enjoying full cooperation from the Mississippi Delta Experiment Station and from other agricultural agencies throughout the Southern States interested in this work.

COTTON DEMAND—TRENDS, CHANGES, AND CAUSES

Recent developments in the world cotton situation have emphasized the need for more information about the world demand for American cotton. This fact became apparent during the 1929-30 and 1930-31 cotton seasons, when cotton prices declined drastically, although production in this country was not unusually large. This decline in cotton prices may be attributed largely to a reduced

demand for American cotton in consonance with the general business depression and to competition from other growths of cotton and other textile fibers.

Compilation, interpretation, and dissemination of information on world demand for American cotton with respect to both quantity and quality are objectives of this project. Such information is in demand from cotton growers and those upon whom they depend for advice, being needed in planning the adjustment in production to meet world market conditions. This work is being carried on in cooperation with the Division of Foreign Agricultural Service of this bureau.

COTTON-PRICE STUDIES—RELATION OF PRICE TO QUALITY

Where the prices received by growers are the same for all qualities of cotton, farmers are more interested in high yields than in good quality, and they find it most profitable to grow the kind of cotton that can be produced at the lowest cost per pound, regardless of quality. As a basis for determining to what extent quality is reflected in the prices received by growers for cotton in local markets, the following work has been carried forward.

Data showing the grade, staple length, date of sale, and prices were collected for approximately 170,000 individual bale sales of cotton in 157 representative local markets during the season 1928-29, 130,000 individual bale sales in 124 local markets in 1929-30, and 90,000 individual bale sales in 136 local markets for 1930-31.

The results of the analysis of the data collected in 1928-29 showed that prices received by growers in local markets varied so irregularly that some farmers received considerably higher prices for the lower grades and shorter staples than other farmers received for the higher grades and longer staples in the same markets on the same days. These irregular variations are accounted for by differences in classification, differences in bargaining power of farmers, and other factors.

The average premiums received by growers for grades above Middling amounted to less than 50 per cent of those paid in central markets.

It has been pointed out that the proportion of the different grades and staple lengths of cotton produced in the United States can be brought more nearly in line with consumer demand and the net return to growers as a group can be increased (1) by perfecting the marketing system so that the prices received by growers will reflect accurately the differences in spinning utility of the different grades and staple lengths, and (2) by giving farmers accurate information on the relative profitableness of producing cotton of different grades and staple lengths in each locality.

ADAPTATION OF COTTON TO NEW AND EXTENDED USES

The decreased consumption of American cotton both at home and abroad, together with the low price, has given timeliness to the work on new uses and has confirmed the wisdom of according it a permanent place in the program of agricultural activities. The critical period through which the cotton industry is passing makes it imperative that work which will actually help to sustain the present con-

sumption of cotton be carried on, as well as researches into the properties of cotton and other fibers looking toward the discovery of basic information which will make for a greater consumption of American cotton.

During the past year a study of the cotton-picking sacks, cotton-picking sheets, and tarpaulins in use on the cotton farms of the United States, 1929, has been completed, and a report giving the results has been submitted for publication. This study shows that approximately 50,000 bales of cotton were estimated to be in use in the United States in 1929 in the form of cotton-picking sacks, cotton-picking sheets, and tarpaulins. It is estimated, further, that more than 33,000 additional bales of cotton would have been required had no burlap been used.

The duplex cotton fabric for consumer packaging of potatoes and onions, which was developed in cooperation with the North Carolina State College of Agriculture and Engineering, has been in use for some time. It is estimated that approximately 100,000 bales of raw cotton would be required to manufacture enough 10-pound cotton bags to move our average annual commercial crop of potatoes if these bags were generally used.

The prospects for the use of a cotton bag for packaging oranges look favorable. A representative of this division recently visited the leading citrus-fruit shippers of Florida and reports that they are very much interested in consumer packaging of oranges in cotton bags. This season 700 car-lot shipments of oranges packaged in consumer-size bags were shipped out of Florida. The shipments indicate that the bags are meeting with favor, and with a permanent freight rate on bags as a standard container for citrus fruit, next season should witness a decided trend toward the use of bags. Inquiries made of retail stores in Washington indicate that oranges packaged in bags are meeting with public approval and are highly indorsed by merchants.

An open-mesh fabric has been developed which is suitable for packaging pecans, walnuts, and other nuts. Samples of the fabric have been submitted to bag manufacturers, and from their comments it is believed that this bag will meet with satisfactory reception.

Effort is being made to develop a suitable and economical cotton fabric for patches on cotton bales. Cooperation has been given to the Bureau of Home Economics in developing cotton fabrics suitable for hooked rug foundations.

A study of the different types and sizes of containers used in the milling industry has been conducted during the past year. Data relative to the present use and the potential use of cotton in cotton bags for packaging flour, wheat offal, mixed feed, etc., are being compiled, and a report will be issued in the near future.

FRUIT AND VEGETABLE DIVISION

WELLS A. SHERMAN, in charge

MARKET NEWS SERVICE ON FRUITS AND VEGETABLES

The bureau's telegraph system, which includes approximately 10,500 miles of leased telegraph wires, continued to be used for the collection and dissemination of daily market information. Twenty-two permanent branch offices were maintained during the year and

40 temporary field stations for varying periods during the heavy movement of important crops. The telegraph service was extended to Fargo, N. Dak., where State officials cooperate in disseminating the information for the benefit of that section. Fifteen other States cooperate in a similar way in furnishing reports and in disseminating information taken from the bureau's telegraph wires, and nearly all of the temporary field stations are financed in part by the States in which they are located.

Daily mimeographed reports are still the backbone of the market news service, although broadcasting by radio and the use of the press have been extended year by year.

The demand for the mimeographed market reports as a basis for the settlement of railroad claims is very active. Many thousands of copies are furnished for this purpose alone. Numerous dealers and shippers maintain complete files of the daily reports for future reference.

A total of 15,252,500 mimeographed market reports were issued to a mailing list of 74,160, an increase of 1,705,500 reports over the record of last year. This division covers peanuts and honey in addition to fruits and vegetables.

CARLOAD-SHIPMENT INFORMATION

Fruit and vegetable shipments amounting to 1,053,019 cars were reported by the transportation lines. Daily shipment reports on 37 products were published by the bureau and complete market reports were issued on 27 of these. In addition, special reports on a number of fruits and vegetables on the Pacific coast and on citrus fruits in Florida were issued.

The shipment information furnished daily by approximately 460 division superintendents and other railroad officials includes the number of cars loaded in each reporter's territory and the name of the State in which the cars originated. These reports are supplemented by monthly summaries.

UNLOAD REPORTS FROM PRINCIPAL MARKETS

Car-lot unloads of all fresh fruits and vegetables have been obtained regularly in 29 cities in which the bureau has representatives. The carriers furnish similar information for 19 of the most important of these products at 37 additional terminal markets, making a total of 66 cities for which figures on the unloads of the principal commodities are available. These unloads are summarized in detail in monthly and annual reports, showing the distribution of the various products and the States of origin of the supplies at each market. Receipts by motor truck were also obtained in several cities, and are included in the unload summaries.

REVIEWS, SUMMARIES, AND SPECIAL REPORTS

Current tabulations of market prices and conditions for all the leading markets and shipping points have been maintained, and reviews, summaries, and special articles based largely on these statistics have been published.

A weekly market review of fruits and vegetables, which analyzes the market movement and prices of the week, has been issued. The

review is mailed out from the Washington office, and is sent also by telegraph to branch offices for duplication and circulation.

This report is given wide distribution by newspapers and journals on the bureau's mailing lists. Many other reviews and summaries are prepared and circulated with the aim of keeping producers and others informed on market conditions affecting the products in which they are interested.

INSPECTION SERVICE ON FRUITS AND VEGETABLES

The total number of inspections of fruits and vegetables, 371,648 cars, broke all previous records. Shipping-point inspection showed an increase of 68,676 cars and receiving-point inspection an increase of 15,103 cars over the previous year.

RECEIVING-POINT INSPECTION

A total of 59,843 carloads of fruits and vegetables were inspected at the 48 markets in which branch offices were maintained and at adjacent points. In addition, large quantities of food products were inspected for the purchasing departments of various Federal agencies.

The policies governing the use of the export form certificate which was issued on all unrestricted inspections of boxed apples and pears, which met the export requirements as determined by chemical analysis, were continued. The export form certificate was refused in all cases where arsenical spray residue exceeded the world tolerance of 0.01 grain per pound of fruit and where the fruit was not entirely free from apple maggot.

CERTIFICATIONS OF APPLES FOR EXPORT TO GREAT BRITAIN

The British embargo of 1930 prohibited the importation of low-grade American apples during the period July 7 to November 15. A special form of certificate was required, showing that each lot of apples met the requirements of one of the recognized grades. This certificate was issued only at the ports and could not be issued at shipping points or any interior market. It was not issued unless the packages were marked to show (1) the name and address of the packer, (2) the variety, (3) grade, and (4) minimum size.

SHIPPING-POINT INSPECTION

A total of 311,833 cars were inspected at shipping points, all but about 2,400 of these being inspected under cooperative agreement with State agencies. In addition, several thousand inspections were made of less-than-carload lots. Work was carried on cooperatively in all but three of the States. In addition, a cooperative agreement for the inspection of grapefruit and pineapples was entered into with a cooperative growers' association in Porto Rico.

INSPECTION OF CANNERY TOMATOES

For several years experimental work has been conducted in connection with the inspection and grading of cannery tomatoes. During the past year approximately 115,000 tons were inspected at factories in five States.

The service was extended to spinach in New York last season, 1,299 tons having been graded when delivered at the canning plants. This phase of inspection and grading work is steadily growing and will be extended to additional States and products next season. Ohio is planning to grade cannery cherries, and the cooperative service on cannery tomatoes will be given for the first time in Delaware, Maryland, and Utah, practically every canning plant in the latter State having signed up for inspection during the 1931 season.

RESEARCH AND STANDARDIZATION

During the year standards for 7 additional fruits and vegetables have been issued, and 13 sets of grades have been revised. Work leading to the establishment of standards for 12 additional products was begun. Canning factories are particularly interested in the establishment of standards for the various canning crops.

United States standards for 50 important fruits and vegetables have now been issued. As in some instances two or more standards are necessary for one commodity because of different types, use, or conditions in various producing areas, a total of 67 sets of standards have been issued.

Studies of the handling and marketing of fruits and vegetables have been made. Mimeographed reports have been issued on the market demand for canned figs, shipping fruits and vegetables in mixed carloads, market preferences and practices involved in the distribution of potatoes, number of packages per carload, and a survey of the bulb industry. Manuscripts have been prepared for technical bulletins on marketing and distribution of fruits and vegetables by motor truck and on the pecan industry, and a statistical bulletin on car-lot shipments of fruits and vegetables.

Circular No. 149, Marketing the Commercial Crop of Early Potatoes, has been published. Unlike the late crop, the early crop of potatoes must be marketed promptly when harvested, and special care must be taken in its harvesting and handling to insure good condition on arrival at market. Since more than 60,000 cars of early potatoes are marketed annually, special attention has been given to outlining successful methods and practices. Information has been made available also on areas and volume of production, commercial varieties, prices, and market preferences in important consuming centers.

Various factors governing market preferences are of interest to fruit and vegetable producers and distributors. The study on market preferences and some practices involved in the distribution of potatoes in six eastern cities shows the trade preferences as to size, origin, pack, etc., of potatoes; reasons for price premiums and discounts; and related information.

Little economic information has been available heretofore in regard to the bulb industry. A mimeographed report, A Survey of the United States Bulb Industry, indicates districts of bulb production and kind and quantity produced. The results of a study of distribution and marketing practices are also included in the report, which should be helpful to producers and handlers of bulbs in developing their business along sound economic lines.

The motor truck has become a very important means of moving fruits and vegetables to market and is having a marked effect on

marketing conditions. A manuscript which has been prepared on Marketing and Distribution of Fruits and Vegetables by Motor Truck summarizes all statistical information on motor-truck movement of fruits and vegetables which is available in the bureau. Detailed surveys of the motor-truck movement in important areas were made and receipts in a number of cities were recorded. Judging from the sample studies, it seems probable that in 1929, 150,000 to 200,000 cars of fruits and vegetables moved to market by motor truck from beyond the market-garden area (a distance of 20 miles or more), compared with slightly more than 1,000,000 cars which moved by rail and boat. In addition to statistics on movement, various economic aspects of motor-truck transportation of fruits and vegetables are discussed in this manuscript.

Perhaps no information on fruits and vegetables published by the bureau in permanent form is more widely used by shippers, city dealers, and others interested in the industry than the bulletins showing the car-lot shipments from stations in the United States. This type of bulletin, which includes figures for two years in each issue, is issued periodically. The bulletin covering shipments for 1928 and 1929, which is in the hands of the printer, also includes information on shipping dates of various fruits and vegetables by States and a summary of available information on motor-truck shipments from certain areas.

Surveys have been carried on in cooperation with other divisions of this bureau and with outside agencies. There is a constant demand for information on the origin of shipments, market receipts, movement of products, comparative prices, etc., which this division aims to meet through the compilation and analysis of data gathered through the news and inspection services.

STANDARD CONTAINER ACTS

A total of 10,695 containers were tested by the bureau, an increase of approximately 70 per cent over the number tested last year. Approximately 40 per cent of the tests were of hampers, round-stave baskets, and splint baskets covered by the act of 1928, and 60 per cent were berry boxes, tills, and climax baskets covered by the act of 1916.

The act of 1928 requires manufacturers to submit specifications to the Department of Agriculture for approval.

The bureau continues to carry on educational work in order to bring about full compliance with the law. It was necessary, however, to report 12 cases to the Department of Justice for prosecution and several persons were found guilty of manufacturing, selling, or shipping illegal containers. Fines were assessed and nonstandard containers were ordered destroyed by the court.

PERISHABLE AGRICULTURAL COMMODITIES ACT

Although the perishable agricultural commodities act had been under discussion for several years prior to its enactment, its passage brought a flood of questions from all parts of the trade; questions which showed that, while the trade understood and approved the basic principles of the law, there was a lack of information on important details. For this reason it seemed important that the law should be

discussed and explained to the trade through a series of meetings in different sections of the country. These meetings were arranged by the trade organizations at various points throughout the United States.

A conference with representatives of trade organizations was held in Washington on July 17 for the purpose of securing trade views on proposed rules and regulations under the perishable agricultural commodities act. Following this conference, the proposed regulations were printed in the trade papers, and a conference with the trade in general was held in Chicago on August 11 and in New York on August 20. At both meetings there was free discussion of the act in general and the proposed regulations in particular. The regulations were promulgated on October 4, 1930, as Service and Regulatory Announcements No. 121. At the close of the fiscal year, 16,151 applications for licenses under this act had been received.

Complaints and requests for investigations began to be received by August, 1930, and continued at an average of 32 per week for the remainder of the year. Of the 1,527 cases received, 824 were investigated and closed and 703 were still pending at the close of the year. More than one-third of the cases concluded were closed as the result of amicable settlements being reached. Of the 703 cases pending at the close of the year, 102 had been sent to the solicitor of the department for legal action.

Of the 1,527 complaints received, 790 were for rejection without reasonable cause, 224 for failure to deliver without reasonable cause, 474 for failure to account correctly, and the remainder were on various other grounds.

PRODUCE AGENCY ACT

A total of 296 complaints were received under this act, 217 of which were closed and 79 still pending at the end of the year. Thirteen cases came to trial during the year, and every case resulted in a conviction. The work under this act is carried on in close cooperation with the perishable agricultural commodities act.

DIVISION OF LIVESTOCK, MEATS, AND WOOL

C. V. WHALIN, in charge

MARKET NEWS SERVICE ON LIVESTOCK, MEATS, AND WOOL

A market-reporting service covering daily price and market conditions for hogs moving direct from the farms in Iowa and Minnesota to packers was inaugurated. A field office which was opened at Des Moines covers 22 concentration yards and 7 large packing plants in Iowa and southern Minnesota.

Information on supplies, movement, demand, market conditions, prices, quality of marketings, producers' reactions to market conditions, etc., is received from the various Iowa-southern Minnesota buying stations and from organized sales agencies by telephone and telegraph each market day. It is immediately analyzed and made into composite reports that are suitable to the requirements of local newspapers, press associations, radio stations, leased-wire transmission, and releases to mailing list.

Inasmuch as Iowa produces nearly one-fourth of the commercial supply of hogs in the United States, and since approximately 60 per cent of its annual marketings move direct to slaughterhouses, the information obtained is highly valuable to producers and trade interests. This service has already become very popular in the area covered. Before the end of the year plans were made for inaugurating a similar type of service on sheep and cattle in the Intermountain States and California.

The news service was extended also to Nashville, Tenn., where a branch office is being operated in cooperation with the division of markets of the State of Tennessee. In addition to the regular mimeographed releases, daily market programs are prepared at this point for three radio stations.

At the end of the year branch offices were being maintained in 25 cities. Market conditions and prices on 24 public livestock markets, on 5 of the largest wholesale meat-market centers, and on the Boston wool market were reported. In addition, by continuing cooperative agreements with State and commercial agencies, widespread dissemination of the information was effected from 15 other points at which the bureau's leased telegraph-wire service was provided.

Plans were under way also for the extension of the service to Louisville, Ky., and Casper, Wyo., also for reporting the contract and direct sales of livestock in Montana, the intermountain, and west-coast regions, with headquarters for the intermountain area at Ogden, Utah. These extensions were provided for by Congress in the appropriation act for 1932.

EDUCATION AND DEMONSTRATION

Educational activities have been continued in cooperation with the Extension Service and the Federal Board for Vocational Education. Conferences of county agents and vocational agricultural teachers were attended in a number of States. At these conferences the Federal standards were explained and the value of the bureau's outlook material was shown. The same type of activity was also carried on at the request of many State or district livestock associations.

Requests for this work reflect the constantly growing producers' interest in marketing and economic information. During the year 36 assignments were filled in 16 States, and more than 19,000 persons attended the various meetings and demonstrations held.

In cooperation with the extension services of nine States, 93 livestock-grading demonstrations were held at ranches and farms. Members of this bureau attended National, State, and district livestock association conventions, where economic conditions, marketing problems, and the agricultural outlook were discussed, and many economic conferences were held with various interested groups.

Considerable attention was given to refining the plaster models illustrating the types and grades of slaughter hogs, which were developed during the previous year, and to working out methods of preparing these models from material which would resist breakage.

MEAT-GRADING SERVICE

The general meat-grading service is now available in 15 cities. Among the more important additions to those making use of the service during the year are the New York City hospitals, Girard College, and the Philadelphia penal institutions. Grading service on all meats has been continued for one large corporation in connection with the sale of precut and packaged meats which it inaugurated during the previous year. Increasing interest is being manifested in the service by stockmen, meat distributors, and large consuming organizations, such as hotels, clubs, dining-car service, and meat distributors.

Special service was rendered the national soldiers' homes through a careful check of meats, meat-food products, poultry, butter, eggs, and cheese delivered by contractors to the various homes. As a result of this service products below grade requirements were either rejected at the time of delivery or deductions were made on invoices.

BEEF GRADING AND STAMPING

The beef grading and stamping service, which provides for stamping beef with a roller stamp so that the grade appears on the retail cuts, has been continued. The total of 102,000,000 pounds of beef graded and stamped represents an increase of about 110 per cent over the previous year.

The demand for United States graded and stamped beef has come from many sources, particularly from national chain-store organizations, numerous local chains, and at least one voluntary chain with a membership of 189 independent retailers. Many independent carlot receivers at eastern markets are using the Government's beef grading and stamping service nearly every day, and hotel and restaurant supply houses in most large cities are constant users of the service.

Reports indicate that a large percentage of the better hotels and restaurants restrict their purchases of beef to that bearing the United States grade stamp, and some of the more prominent hotel chains have issued instructions to their units to limit purchases of beef to that bearing the "United States Choice Steer" stamp. The increased use of United States graded beef by the dining-car departments of practically all the large railroad systems has been a feature in the year's development.

LAMB-GRADING SERVICE

Grading and stamping lamb at Detroit, Buffalo, and Erie was new work undertaken during the year. It was begun in response to demands from local packers in the three cities, and the work is handled by the beef graders stationed at those points. The charge for this service is the same as for beef grading, namely, \$2 per hour for the grader's time. The demand for Government-graded lamb is increasing, and arrangements are being made to extend the lamb-grading service to other cities where beef-grading service is available.

THE STATISTICAL SECTION

Daily livestock prices are compiled and tabulated by 62 class weight and grade selections at 24 markets; daily fresh-meat prices by 45 class weight and grade selections at 5 markets; daily cured-

meat prices by 21 class weight and grade selections at 4 markets; weekly wool prices at Boston; weekly, monthly, and yearly averages of these prices; actual daily receipts of cattle, calves, hogs, sheep, and horses and mules at 18 markets; monthly gradings of meat by class; and many other types of information are handled.

In addition, a large volume of statistical work is carried on regularly at the leading market centers—Chicago, Kansas City, Omaha, and St. Paul—in connection with the market-reporting service. The work involves compiling records showing the State of origin of market receipts and the shipments of stocker and feeder cattle and sheep by class, grade, weight, and destination.

Reports are released weekly and monthly to a regular mailing list, giving a summary of the average prices of livestock, meats, and wool at the leading markets, compared with previous corresponding periods; the retail prices of meats; the receipts, stocker and feeder shipments; total shipments and slaughter of livestock weekly at 12 markets and monthly at all public stockyards; estimated monthly production and consumption of meats; and other market information.

GRADE STANDARDS FOR WOOL

During the year 271 sets of official wool and wool-top standards were distributed, 10 of which were issued to the Treasury Department for use at ports of entry and elsewhere as authority for grades of imported wool. Sets have now been sent to almost every important wool-producing or wool-consuming country in the world.

A series of studies has been inaugurated pertaining to the inter-relationship of diameter and length and structure of the wool fiber, as a foundation for further studies in spinning properties, behavior, working qualities, and utilization of the various types and grades of wool of the United States.

WOOL SCOURING AND SHRINKAGE INVESTIGATIONS

Grade analyses and scouring tests on wool samples were continued. As this work is done under standard conditions the reports of the tests forwarded to growers, wool pools, cooperative associations, and others are of value to them in determining the grade and shrinkage of the entire lot of wool they produce or handle. The tests made for experiment stations and special stock breeders are used in studying the effects of climatic conditions, feed, etc., on the grade and shrinkage of wool and in evaluating the results of wool-breeding experiments.

SLAUGHTER TESTS

Research in developing grade standards for livestock consisted of making a number of slaughter tests to determine the relationship of the grade of the live animal to the measurable physical and chemical characteristics of the carcass and the various wholesale cuts, and actually grading a large number of animals for the purpose of ascertaining the correlation between the grade of the live animal and the grade of the carcass obtained therefrom. Descriptions of tentative standards for six grades of slaughter sows were drafted as a result of these studies, and revisions were made in the tentative standards for the six grades of slaughter barrows and gilts.

Slaughter tests were conducted in cooperation with packers in Baltimore and Chicago. They showed definite relations between the tentative type and grade standards and the dressing yield and the percentage yield of cuts and leaf fat. Such cuts as bacon bellies, fatbacks, clear plates, jowls, and leaf fat decreased in percentage yield uniformly from the Prime to the Common grade, while hams, picnics, Boston butts, and loins showed an increase in the percentage yield as the grade was reduced.

Tests were conducted at the experimental abattoir at Beltsville, Md., in connection with the studies that have been in progress for several years as part of the investigations of quality and palatability of meat. These investigations are being carried on in cooperation with the Bureaus of Animal Industry and Home Economics and various State experiment stations. The animals used in these tests were in most instances first graded as feeder animals, later as slaughter animals, and finally as dressed carcasses. A considerable number of these carcasses were then used in obtaining data on the yields and dimensions of various cuts and the relationship of such cuts to the carcass as a whole. The information obtained is expected to be especially helpful in refining the grade standard specifications and establishing them on a more definite and concrete basis.

HIDES AND SKINS

Considerable progress was made in the development of grade standards for hides and skins. A mimeographed publication, entitled "Tentative Market Classes and Grades of Kips and Calfskins," was prepared after many conferences with those interested in the hide and leather industries, and approximately 3,000 copies were distributed to tanners, hide dealers, and others.

Weight ranges recommended for the tentative market classes and grades of hides and skins are being used by the Bureau of Customs of the Treasury Department in connection with the allowance of repayment of duties on all leather exported which was made from foreign hides and skins.

SUPPLY, DISTRIBUTION, DEMAND, AND PRICE STUDIES

The work of analyzing and interpreting statistical material relating to livestock and meat supplies, market movements, demand conditions, prices, and distribution of animal products into consumptive channels was expanded. Producers, slaughterers, and meat distributors are now looking to the bureau for economic information for use in planning their production and marketing operations and in working out plans for necessary readjustments to meet new conditions.

The information developed through analytical studies serves as a basis for the semiannual livestock outlook reports. It is also used in preparing the numerous price and situation reports, radio talks, reviews, and addresses which are released or delivered at various intervals. Since the statistical-analysis work, to be of value, must have at hand reliable and comprehensive data relating to supplies, demand, movements, and prices, there is complete coordination and cooperation between the market news staff, the statistical and research sections, and other divisions throughout the bureau.

The annual statistical report on meat production, consumption, and foreign trade of the United States was prepared for general distribution to those interested in such information. There is an extensive demand for this report from research workers, statisticians, meat distributors, and others.

During the latter part of 1930, data on the slaughter operations of certain groups of large-scale slaughterers over a period of 10 years were assembled and summarized for use as evidence in the hearings before the District of Columbia Supreme Court in connection with the application of these slaughterers for modification of the packer consent decree.

RETAIL MEAT-PRICE STUDIES

A new project on compiling and analyzing retail prices of meats collected by the market news staff in New York and Chicago was started. The severe decline in livestock prices brought an urgent demand from livestock producers and others for more timely and comprehensive information regarding price trends in retail meat markets. Producers apparently were of the opinion that the consumption of meats was being retarded because retail prices were not being adjusted in line with the declines in livestock prices and that this was having a very adverse effect on the livestock situation. In order that producers and retailers might be kept fully informed on current prices and the actual readjustments being made, one specialist has devoted his entire time to a study of the retail meat-price structure and the yields of the various retail cuts, and has compiled composite retail prices which would permit comparison with prices in the wholesale market and in the livestock markets.

Retail prices collected in New York and Chicago were used for analysis and comparative purposes. These prices are obtained twice a month from a large number of stores of various types in both cities, and so far as facilities permit they are classified according to grade of meat sold and kind of service rendered, namely, credit and delivery or cash and carry. Composite prices, computed on the basis of grade and total carcass weight and value, are used for comparisons with wholesale carcass prices and livestock prices. Such comparisons show the actual readjustments being made and also the gross margins between prices paid for livestock and prices paid for meat at wholesale or retail. The information thus compiled is being made available to the public at regular intervals and is being used by the meat-trade periodicals.

DIRECT MARKETING OF HOGS

Research in the field of livestock-marketing methods was limited to studies of direct marketing of hogs. This method of marketing has attracted much attention because of the marked increase in the number of hogs being sold direct to slaughterers compared with the number sold on public livestock markets.

A comprehensive study of this subject was outlined and field work was begun in the spring of 1931. The phase of the problem which is receiving attention at present is that of comparisons of shrinkage in transit, dressing yield, and the relationship between live and dressed cost of hogs purchased direct and at public markets. Most

of the hogs bought direct are priced and settled for on the basis of weights at local shipping points or at concentration yards. Hogs purchased on public markets are never settled for on loading weights.

The general impression among packers is that hogs which were heavily filled on the farm have shrunk by the time they reach a public market, and although hogs are usually fed and watered upon arrival at a public market before being offered for sale, this fill is not likely to be excessive. Since the dressed yield of hogs is of vital importance in pricing the animals and since opinions differ as to what effect the different methods of handling hogs have upon this yield, this subject should receive intensive study.

Packers that buy hogs both direct and at public markets are furnishing data for this study. Plants killing hogs from the Middle West and located at public markets, at interior points near the source of supplies, and in Eastern States are included. The data for this study are obtained by individual lots, a lot being usually one or more decks of hogs. Comparisons will be made between hogs coming to these plants from various shipping points.

Data have been gathered on about 27,000 lots representing 4,500,000 hogs. Half of these will permit analysis of shrinkage, yield, and the relationship between live and dressed cost, while only shrinkage data are available for the other half. About nine additional plants will be included and will bring the aggregate total to about 40,000 lots, or approximately 7,000,000 hogs. It is expected that a preliminary report on the study can be released early in 1932.

GRAIN DIVISION

H. J. BESLEY, in charge

ENFORCEMENT OF THE GRAIN STANDARDS ACT

A new record was established during the year in the number of appeals handled by the several field offices. Appeals were carried to the department for final grading and certificating on 86,608 lots of grain which had been graded by inspectors licensed under the grain standards act. This is an increase of about 8 per cent over the preceding year. Of the total number of appeals handled, the Federal grain supervisor sustained the grade assigned by the licensed inspector in 71 per cent. The grade was raised in 10.1 per cent and lowered in 18.9 per cent of the cases. The inspection fees and charges on the appeals returned to the Federal Treasury were approximately \$117,300.

Complex administrative problems have presented themselves during the year because of the large surplus of wheat carried over from previous crop years and because of the activities of agencies operating under the agricultural marketing act. In this connection a survey of the quality and condition of the stocks of wheat held in storage in terminal markets and in country mills and elevators by the Grain Stabilization Corporation was made pursuant to a request made to the Secretary of Agriculture by the president of that corporation. This survey was made in the spring months by members of the board of review and district officers assigned to specified territories or areas. Approximately 87,000,000 bushels were examined, and a report was rendered to the president of the Grain Stabilization Cor-

poration. In addition, an examination was made of the stocks of wheat of the Grain Stabilization Corporation at Buffalo and at the Atlantic and Gulf ports for the purpose of informing the corporation of the approximate grades of its wheat in those locations.

Late in the fiscal year the Grain Stabilization Corporation engaged in a large movement of wheat from important primary points into terminal markets in order that the channels of trade might be kept open for the movement of the new crop of wheat. This movement has necessitated the reassignment of this bureau's force of supervisors, particularly in the Missouri River areas and farther southwest, for the purpose of handling the very large number of "out" appeals which the corporation called as a matter of general policy on all deliveries made to it.

The regular enforcement activities were conducted as usual. Seven cases of alleged fraud were investigated and closed, and several cases were pending at the close of the year. The field supervisors of this bureau act as agents of the Food and Drug Administration in preventing the adulteration of grain and the sale of products unfit for food. The chief form of adulteration encountered was the addition of water to dry oats and wheat and of screenings to corn. A general decrease in the use of screenings and musty, damaged wheat for mixing purposes has been noted. It is believed that objectionable practices can largely be eliminated by a wider diffusion of information on the kinds of material which the department considers unfit for use. Special attention has been given to the control of stocks stored for export.

EDUCATIONAL ACTIVITIES

The educational committee conducted educational campaigns and maintained contacts with producers, extension, and crop-improvement organizations throughout most of the grain-producing sections of the country. More than 1,000 country grain buyers and many leading producers attended grain-inspection demonstrations held in 11 grain-producing States. In four States railroad cars were equipped as grain-grading laboratories and moved from place to place.

This work was not only the means of instructing country grain buyers and producers in the application of the standards but also brought about close contacts between Federal grain supervisors, the extension services, and organizations representing producers and shipping-point buyers.

MILLING, BAKING, AND CHEMICAL LABORATORY

A study is being made for the purpose of obtaining information on what constitutes wheat quality. Extensive milling, baking, and chemical tests were made on 1,300 samples of wheat of different quality, grade, or condition for the purpose of noting differences in characteristics. Using the milling, baking, and chemical characteristics of country-run wheat as a standard of excellence a tentative scoring system was established. Comparative tests were made with terminal market-outturn wheat (milling as well as contract type) and export wheats from different areas. The same scoring system was applied. From the study it was possible to follow the variation in the milling

and baking quality of wheat as it moved from the country through the terminal markets and on into export channels. Furthermore, as the studies were made on a scoring basis, it was possible to state the degree of variation numerically.

A study of methods for estimating soundness in wheat was continued. It is apparent from the progress made that the problem is complicated and that it will be some time before definite conclusions can be announced. Approximately 3,500 tests were made this year in this study.

Research in the utility of electric moisture-testing devices of the rapid type has been continued. One device has proved satisfactory for hard wheats (spring, durum, and winter) and for corn. Studies are being made of the causes for unsatisfactory performance with the soft wheats, both red and white. The perfecting of the device for determining moisture in the other cereal grains was seriously hampered because of lack of material. Drought conditions dried the oats, barley, rye, etc., to such an extent that no range in test samples was available.

Many hundreds of milling, baking, and chemical tests have been made in connection with both the research and regulatory problems under the grain standards act and with the work of the Bureau of Plant Industry on cereal investigations.

RICE-GRADING SERVICE

The Federal-State rice-grading services conducted in Texas, Louisiana, and California were continued. A large part of the rice involved in foreign and domestic shipments is now graded under Federal supervision and sold on the basis of Federal-State grade certificates. The analyses as given on the grade certificate are used as a basis for establishing the value of rough rice to be sold. Most of the export trade uses the Federal rice grades when purchasing milled rice.

HARVESTING AND HANDLING OF RICE

A 3-year study of the use of the aspirator for cleaning rice at the stationary thresher was concluded. Investigations were conducted also in adapting the aspirator to the combine in harvesting rice.

A survey was made of the windrow method of harvesting rice and much valuable information was obtained. Studies were made also to determine the amount of shrinkage in weight sustained by rice as a result of the handling and drying operations at an elevator. The milling quality of various types of rough rice was studied at several rice mills.

Studies were completed on the artificial drying of rough rice and sorghum on the farm in a simple farm-built drier. The results showed that the storage qualities and marketability of the crops were improved and that the drying of the grain enabled the farmer to use the bulk method of handling and storing.

BULK HANDLING OF GRAIN AND RICE

Investigations into the economic advantages of handling grain and rice in bulk on the Pacific coast were continued in cooperation with the University of California. The results of several years' study were published in a circular entitled "Bulk and Sack Handling of

Grain in the Pacific Coast States." One result of the cost studies of bulk and grain handling was the adoption by a grain dealers' association in the Pacific Northwest of a number of changes in the schedule of discounts for grain handled in bulk. The basis of quotation was changed from sacked to bulk grain.

The best equipment for bulk handling of grain was also studied. Suggestions were made for a cheap and satisfactory bulk storage bin to be used on side hills and allowing the grain to be moved by gravity without the use of machinery. Investigations were made also on the effect of bulk handling on the grade and market value of barley. Certain phases of the bulk-handling problems have been studied by the Division of Farm Management.

DIVISION OF DAIRY AND POULTRY PRODUCTS

ROY C. POTTS, in charge

RESEARCH PROJECTS

Work was continued on a number of research projects in cooperation with other divisions of the bureau. Progress was made on studies of per capita consumption of milk and cream in cities in the United States and of consumption of dairy and poultry products on farms. The effect of changes in income and other factors upon the consumption of dairy and poultry products also is being studied. Data obtained from the various studies are being prepared for publication and have been used in preparing outlook reports and other releases of the bureau.

MARKET NEWS SERVICE

New reports covering the poultry industry were inaugurated as follows: Weekly egg market report; weekly poultry market report; monthly report of egg-breaking establishments; daily egg price report at Philadelphia; and daily price report on live and dressed poultry at Portland.

The first two reports are issued from the Chicago office to a mailing list of over 4,000. They summarize the important statistics on the commercial movement, supply, and prices of poultry and eggs, as well as trade conditions in the important terminal markets. These new reports have been received with interest by the trade and give promise of becoming valuable additions to the market news service.

The monthly report on operations of egg-breaking establishments shows the quantities of eggs broken monthly and the amounts of liquid whites, liquid yolks, and liquid mixed whites and yolks produced in the United States. An increase in the tariff on liquid and dried eggs has stimulated the operation of egg-breaking plants in the United States and has increased the demand for market information. More than 400 firms are on the mailing list for this report.

The monthly hatchery reports for 1931 were begun in January instead of in February as in previous years. These reports are distributed to a mailing list of nearly 4,000 firms and are widely published in poultry trade journals.

Daily reports were issued on car-lot shipments of dressed turkeys from Texas and Oklahoma passing through the railroad gateways

of Kansas City, St. Louis, and Chicago to eastern markets. Both shippers and terminal-market receivers were greatly interested in this information, and it is proposed to enlarge the scope of these reports to include all western car-lot shipments of turkeys moving to eastern markets.

The monthly report on market milk prices was enlarged by the addition of information showing the average daily purchases per producer by milk dealers for a large number of important areas. This new information was compiled at the request of the industry and it is obtained from a large number of milk dealers' and producers' associations who furnish data on the number of producers from whom milk is purchased and the total quantity of milk purchased. This makes it possible to calculate the average daily purchases per producer for each area or market.

The monthly condensed and evaporated milk market report was expanded also to show similar information regarding the average daily purchases of milk per producer by condenseries.

The monthly dry-milk market report was expanded to include information on the tone and trend of the casein market and the prevailing prices of casein.

At the Chicago office a new post-card report was inaugurated giving the prices on 92 and 90 score butter and 90-score centralized car lots, and the tone of the market and trading conditions. This report is issued primarily for the information of cream-station operators and is sent daily to a mailing list of over 7,000.

At a number of markets at which receipts of butter, cheese, eggs, and dressed poultry are compiled, arrangements were made to improve the reports by including more complete information on receipts by parcel post and truck. Parcel-post receipts of eggs at Boston are now included, as well as truck receipts of milk and cream. At New York receipts of poultry and eggs by motor truck are obtained, and it is planned to include motor-truck receipts of milk and cream. Cheese receipts at Chicago by motor truck are now included.

The quarterly report on production of manufactured dairy products has been superseded by a semiannual report which furnishes the same information by months and by States. This change has reduced the number of schedules sent to each firm, and it is believed that it will result in more complete information, thus affording a more accurate basis for the monthly estimates of butter and cheese production. Cooperation with the States in compiling this report was extended to include Wisconsin. This extension should result in obtaining more complete statistics on dairy products manufactured in that State.

The demand for market statistics has increased greatly. The number of persons on the regular mailing lists for reports has increased by nearly 25 per cent during the past year. Many special reports and summaries have been prepared also to meet the needs of particular groups or localities.

GRADING OF DAIRY AND POULTRY PRODUCTS

Several minor changes were made in the standards for dressed poultry, and the grade names were changed from United States Prime, United States Choice, United States Medium, and United States Common to United States Special, United States Prime,

United States Choice, and United States Commercial. No changes were made during the year in the standards for butter, cheese, or eggs.

There was an increase in the total number of grading or inspection certificates issued on all products, the principal increases being in the amount of butter and dressed poultry graded.

Previous to the past year no dressed poultry had been graded except at Washington, D. C. During the year this service was extended to San Francisco, Portland, and Seattle. It was undertaken also for groups of shippers at 34 shipping points in 7 mid-Western States. The grading is done by licensed graders under the supervision of this bureau. Each bird is labeled to indicate the proper United States grade and the grade tag is attached with a metal United States seal. During the fiscal year a total of over 2,000,000 pounds of dressed poultry was graded at shipping points, exclusive of dressed turkeys.

The grading of dressed turkeys was extended to shipping points in Texas. In order to train men in the grading of turkeys, a series of demonstrations was held at San Angelo, Tex., and was attended by more than 40 persons representing producers' organizations, buyers, and packers. Turkeys were also graded at shipping points in Colorado, Wyoming, Utah, Idaho, Nevada, California, Oregon, and Washington, in cooperation with State agencies.

DIVISION OF HAY, FEED, AND SEED

W. A. WHEELER, in charge

MARKET NEWS SERVICE

The organization of a national market news service on beans was the principal development of this project. Offices were opened at Lansing, Mich., for the pea-bean area and at Denver, Colo., for the sections producing Pinto and Great Northern beans. The established offices of the grain, hay, and feed market news service in California and at Chicago and Kansas City included beans in the service at those points. At the end of the year weekly reviews covering the market situation at the principal distributing points and in the main producing areas were being issued regularly from Washington and from the field offices. The States of California and Idaho have cooperated in the development of the service.

The grain and hay market news services were extended to the Intermountain States with the establishment of a field office at Denver. Comprehensive information is now being given to the grain and hay growers in Colorado, southern Idaho, and Utah. A special weekly summary of market conditions for grain, hay, and feed, applicable to the Southeastern States, is now being issued from the Atlanta office.

The news service on alfalfa hay begun during the previous year was extended and materially broadened. Statistical data required for the effective conduct of the service were compiled and utilized. The weekly reviews were in increasing demand in the Central States, the Southwest, and on the Pacific coast during the year.

Progress was made in developing a more comprehensive service on broomcorn. Methods of obtaining movement and stock figures

were improved and the data were closely correlated with those compiled by the Division of Crop and Livestock Estimates. Comprehensive weekly or monthly summaries of the broomcorn-market situation were issued from Kansas City throughout the year.

Additional contacts were made with the trade to broaden the scope of market information on rice, and the statistical data compiled in the project were improved and refined to make them of greater value to the trade agencies cooperating in their collection and compilation. The distribution of the weekly reviews was extended to California rice growers. The service is now available to growers throughout the southern rice belt and on the Pacific coast.

SEED-REPORTING SERVICE

Regular reports covering prices, supplies, movement, and other data for 42 kinds of field seeds were prepared and distributed. Seed surveys were made and situation reports issued for 25 seed crops. They were based largely on information obtained from about 9,700 country shippers and 30,000 growers, supplemented by data obtained from personal observations in seed-producing districts and from State agricultural statisticians. Foreign information was obtained through contact with foreign correspondents. Data from more than 12,000 retail dealers were assembled and reports were issued regarding prospective demand, retail sales, and prices. Special reports were issued on seed potatoes, cottonseed, vetch, and sunflower seed.

Demands for emergency and special work were heavier than usual. Members of the staff aided the American Red Cross in the purchase of seed, including over 600,000 packages of vegetable seed. A special survey was made of the sales of improved cottonseed for planting, and another was started on the purchase of seed used on golf courses.

SEED-VERIFICATION SERVICE

Approximately 36,700,000 pounds of alfalfa seed and 13,600,000 pounds of red-clover seed were verified as to origin, 65 seed dealers in 22 States having enrolled in the service. It is estimated that they handled 85 per cent or more of the alfalfa seed produced in the Central and Northern States and also a considerable portion of the red-clover seed produced in the United States.

HAY, STRAW, AND ALFALFA-MEAL STANDARDIZATION

The hay-standardization work the past year pertained largely to the study of color. A much improved colorimeter was designed early in the year and one was furnished to each of three field stations, namely, Los Angeles, Kansas City, and San Antonio, in order that the measuring of color might be facilitated at all of these important field stations. Conferences were held with the supervisors in order to compare their judgment of grades with the measurements made with the new machine.

There has been a demand for standards for straw for some time, particularly by the Army, since it is a large purchaser of straw. A large number of bales of straw were received from various sources, and analyses of chaff and color were made on these samples. The

color work on straw shows that there is a rather narrow hue range and that other factors besides hue may have to be taken into consideration in determining the grade of straw.

Progress was made in the research work on alfalfa meal and chopped alfalfa. A technological laboratory for use in the study of alfalfa meal and chopped alfalfa was designed, built, and equipped with up-to-date apparatus. The laboratory is divided into two parts, namely, a laboratory for microscopic and chemical studies and a mechanical laboratory for such studies as grinding, sieving, and aspirating. This new laboratory equipment should facilitate the progress in meal standardization.

CURING SOUTH TEXAS HAY

A study of south Texas hay, in which samples were taken at the time the hay was stored and again after having remained in storage from 9 to 12 months, showed that there is very little loss in color during the storage period. Hay dealers and others asserted that hay lost much of its color during the storage period, but this test would indicate that this idea is not correct. The average difference between the color of the samples at time of storing and at the end of the storage period was 5 per cent.

HAY CURING AND STACKING STUDIES AND THEIR RELATION TO QUALITY

A study of hay curing and stacking was begun in the Platte Valley in Nebraska with the agricultural experiment station of Nebraska. The results of the season's work seem to indicate that the principal cause for the stack spotted condition of the hay in the Platte Valley is either excessive moisture at the time the hay is stacked or penetration of rain and snow water during the fall and winter. Some farmers were stacking hay with as much as 40 per cent moisture at the time of stacking, which is considered excessive for safe storage. This project is of much interest in that section, because it is practically impossible to separate moldy hay from the sound hay when baling from the stacks, and all the hay which contains moldy and musty spots or flakes is graded as Sample grade.

HAY INSPECTION

Most of the mid-western markets showed a considerable decrease in the demand for inspections because of smaller receipts of hay at those markets. Other sections showed an increase which nearly offset this decrease. The business in California has continued to grow, several new inspection points being established there, so that Federal-State inspections are now being conducted at Los Angeles, San Francisco, and in five shipping sections. There was a large increase in the volume of business at Omaha, and also at Denver because of an arrangement by which the hay for the Denver stockyards is now inspected. The State-Federal inspection service in Oklahoma made the largest number of inspections that have ever been made in that State. A large amount of south Texas hay was inspected at Houston, Tex., for delivery principally to the Army. New inspectors were installed at Fort Worth, Tex., and in Wilson County, Kans., while the service was discontinued at Richmond, Va., and in Wisconsin, because of lack of demand.

BROOMCORN INSPECTION AND STANDARDIZATION

Standards for broomcorn issued tentatively by the bureau were discussed at several meetings of broom manufacturers held at Washington last winter in connection with the organization of the Broom Institute. Standards adopted for brooms to be made by this group were based on the revised standards for broomcorn after a few changes had been made. The standards thus revised were recommended as department standards effective March 1, 1931. Demonstrations of the broomcorn standards were held at Tucumcari, N. Mex., and were well attended.

BEAN STANDARDIZATION

In cooperation with the State department of agriculture of California a special survey was made of problems in producing and preparing beans for market under conditions prevailing in California. This study has resulted in slight changes in the grade requirements for California beans which became effective September 1, 1931.

A study based on data obtained in connection with the inspection service indicates that the grades for beans produced outside of California reflect more accurately the commercial quality of the respective classes. No change in the grade requirements for these classes seems desirable.

The total number of inspections made of beans was 3,361, an increase of more than 30 per cent. Federal inspection was made available to shippers in Michigan by the opening of a branch office in Lansing.

SOYBEAN INSPECTION

The number of inspections of soybeans during the year was 3,007, compared with 987 in 1930. This is accounted for by unusually heavy receipts at mills and by increased interest in the inspection at shipping points in North Carolina.

The expansion of the soybean-crushing industry made it necessary to extend the inspection service to Taylorville, Ill., and to Indianapolis and Lafayette, Ind. Upon request of the Federal Intermediate Credit Bank, of St. Louis, about 500,000 bushels of soybeans stored in elevators at Peoria, Bloomington, and Taylorville, Ill., were inspected for grade and condition. This work was done by local licensed inspectors under the supervision of this office.

DIVISION OF WAREHOUSING

H. S. YOHE, in charge

Continued progress was made in licensing warehouses under the United States warehouse act. The licensed capacity for cotton warehouses increased from 3,971,135 bales on June 30, 1930, to 4,830,339 bales on June 30, 1931; licensed capacity for grain increased from 54,064,618 bushels to 74,804,092 bushels; and for canned foods from 2,672,900 cases to 3,464,450 cases. The capacities for other products increased in somewhat smaller ratios.

These figures on capacity do not represent the volume of products that may be handled through licensed houses in a year. Some cotton warehouses may handle cotton amounting to two or three times their

licensed capacity each year, and it is not uncommon for a grain elevator to handle grain amounting to ten times its capacity in a year. From best available figures it appears that more than 50 per cent of the cotton crop is handled through federally licensed warehouses, while close to 400,000,000 bushels of grain pass through licensed grain facilities annually.

ADDITIONAL PRODUCTS PLACED ON ELIGIBLE LIST

During the past five years the department has been requested to place alfalfa seed on the eligible list for storage, under the warehouse act. After considerable study of the subject, regulations for the storage of seed were promulgated on November 21, 1930. These regulations defined seed as "Cleaned and hulled alfalfa seed, the identity of which is preserved while in storage." These regulations have since been amended to include uncleaned alfalfa seed and also bluegrass seed, both uncleaned and cleaned.

Amendments were made to the potato regulations to permit the storage of seed stock, as well as commercial or table stock.

CANNED-FOODS WORK

Work was continued on the preparation of standard grades for canned fruits and vegetables. Official grades for canned tomatoes, canned peas, and canned corn, both whole-grain and cream style, were promulgated. Further study was given to the tentative grades for canned beets, Lima beans, snap or green beans, spinach, sauerkraut, pumpkin, and succotash. A tentative draft of grades for canned grapefruit was submitted to the trade for criticism and suggestion. Preliminary studies have been made with a view to drafting standard grades for canned peaches, pears, apples and apple sauce, some of the smaller berries which are frequently canned, and for tomato pulp, catsup, and other tomato products.

A number of conferences were held with various committees of canners interested in uniform grades. To assist the various governmental agencies purchasing canned fruits and vegetables, conferences were held with the general provisions committee of the Master Specifications Board. As a result of these conferences, many of the ideas embodied in the department's standard grades have been incorporated in the specifications applicable to Government purchases to become effective July 1, 1931.

AMENDMENTS TO THE WAREHOUSE ACT

On March 2, 1931, a number of amendments were made to the warehouse act, the most important of which were:

Authority to permit the Secretary to designate as his representative some one to perform a number of duties with which the act formerly charged the Secretary.

The elimination of that section which required a warehouseman to furnish bond to guarantee the performance of his duties under State law.

Authorizing the increase of fees for inspecting and licensing warehousemen and also authorizing the charging of fees for licenses issued to inspectors, samplers, weighers, and graders.

Amending the penalty section of the law to increase the scope of punishable offenses and to increase the imprisonment term from 1 to 10 years.

Conferring upon the Secretary exclusive jurisdiction over all licensees under the warehouse act so long as their licenses remain in effect.

Since the passage of these amendments the various regulations issued by the Secretary have been amended to meet the changes in the law, and the regulations for wool and grain warehousemen have been completely revised.

DIVISION OF STATISTICAL AND HISTORICAL RESEARCH

O. C. STINE, in charge

Continued effort has been made to present the facts concerning the world situation of the principal agricultural products. Much of this information is gathered by the various service divisions of the bureau, but it is necessary to assemble and analyze all of the factors having a bearing upon the prospects for each commodity. This work is basic to the outlook reports published by the bureau and aims to furnish the information needed in planning production to meet potential market requirements.

In addition to the annual outlook report issued in February of each year, special reports are issued from time to time covering specific commodities, a bulletin on the price situation is issued regularly, and information is prepared for the bureau's publications *Crops and Markets*, and *Foreign Crops and Markets*, and the *Agricultural Situation*. The continued severe business and agricultural depression has added greatly to the work of the division. There has been a steady demand for special information on particular commodities or conditions. Farmers are constantly shifting their production programs in the light of price changes. In making these shifts they have used the best sources of information they have had, namely, the prices they have been receiving. This, however, assumes that prices of one year are a satisfactory index to what the farmer can expect from his crop the following year. The bureau's outlook work is pointing out to farmers that they must consider economic conditions which are likely to prevail when their products are ready for the market. It has been noted that the country at large is taking a keen interest in the bureau's analyses of economic conditions, and it is believed that this work will help to bring about a more intelligent adjustment of the farm program in the light of the forecasts of future demands.

THE WORLD COTTON SITUATION

An outstanding contribution has been the publication of the *World Cotton Situation*. The small mimeographed edition of this bulletin was nearly exhausted at the meeting of cotton interests held at Atlanta last December, and 95,000 copies of the printed edition were distributed on request. In the distribution efforts were made to reach State workers, extension agents, vocational teachers, and leading bankers, business men, and newspapers. Together with the *Outlook for Southern Agriculture*, prepared at the Atlanta outlook meeting, this bulletin furnished the basis for many of the State reports as well as for newspaper articles on the situation. Supplementing the outlook reports, a mimeographed summary, entitled "*World Cotton Prospects*," is issued each month. This material is copied widely by newspapers and periodicals. An index of the prices of factors used in producing cotton has been prepared, and a great deal of time has been given to assembling figures on world demand for cotton.

WORLD WOOL PROSPECTS

A monthly summary carrying all the pertinent information on conditions in the wool markets of the world is published. It includes information on the demand and supply situation for wool in the principal wool-consuming countries, reports on prices in the primary markets, production, consumption, stocks, etc. The estimates of world production published by this bureau are accepted by many foreign as well as domestic publications.

A cooperative study was completed on world production and prices of merino and crossbred wool. This is the first thorough and comprehensive study of world production for the important producing countries covering a sufficient period to permit an adequate presentation of production cycles.

THE DAIRY INDUSTRY

The depression in the dairy industry has required further effort in furnishing adequate information about economic conditions in this field. A meeting of representatives of various sections of the dairy industry was held in St. Louis, Mo., in the spring of 1931 to consider the dairy situation. In cooperation with other divisions in the bureau a special mimeographed report, entitled "The Outlook for the Dairy Industry and Some Essentials of a National Dairy Program," was prepared to furnish the facts and forecasts needed by the conference. Since then this report has been revised and is now available in printed form.

The division has also cooperated with other divisions in the bureau in getting out a monthly report, called the "Dairy Situation," in order to furnish a brief statement of conditions and a summary of statistical information on the industry. World Dairy Prospects has been continued and gives special emphasis to developments in the foreign situation. A year ago a special report was published dealing with the competition from Canada that faces dairymen in the United States. This year a similar report has been issued showing the competition from New Zealand. The report on New Zealand is especially important because of the rapid development of dairying in that country and the fact that its surplus comes on to the world markets in our winter season.

It is recognized that a national dairy program requires a thorough understanding of demand conditions, and to meet this need special studies have been made of the factors influencing consumer demand in several areas. Milk-consumption surveys were made in Baltimore and metropolitan Boston in which about 5,000 records were obtained. Analyses of these records show that the use of milk tends to be affected by nationality, per capita income, and the number and age of children in the family. Absence of young children tends to lower a family's consumption of milk, since adults consider it children's food. The factors found to be most important in stimulating consumption are education and the knowledge of the value of milk in the diet.

POULTRY AND EGG PRICE STUDIES

The poultry and egg price studies are nearing completion. The cycles, mentioned in last year's report, have been revised slightly by an improved method of analysis and now include data for all of

1930. It was found that these price cycles are rather definitely related to the business cycle and to a production cycle. In the course of the analysis it was found that, for egg prices at least, deflation by the Wholesale Price of All Commodities Index is not an accurate method to use in eliminating the effect of price level.

WORLD WHEAT PROSPECTS

Each week a statement is prepared showing daily and weekly average prices of a number of principal grades of grains, together with the weighted average prices of all classes and grades of each of the grains at six important markets. These weekly statements are mailed to a small group of people who have specially requested them. Each month a statement is prepared showing weekly average and monthly average prices of grains at these markets. In addition to the weighted average prices, other price statistics and statistics of receipts and shipments, grain stocks, inspections, and similar data are compiled for various markets of the United States and certain foreign countries. A record of acreage and production estimates of grains of all the countries of the world is also kept.

A mimeographed bulletin, entitled "World Wheat Prospects," is issued monthly with occasional supplementary issues.

The annual Outlook Report includes statements on wheat, corn, oats, and barley based upon price analyses and statistical compilations. In addition to the annual outlook reports, there are in the case of wheat two regular supplementary reports, the Spring Outlook Report and the Fall Outlook Report, each of which is issued following the gathering of information concerning farmers' intentions to plant.

Of outstanding importance was the preparation last summer of a statement on wheat facts, which was later revised and printed as Miscellaneous Publication No. 95, *The World Wheat Outlook, 1930, and Facts that Farmers Should Consider*.

A report was completed on durum wheat, bringing together information on the course of production, consumption, and prices of durum in the United States and other important producing countries. This information should be helpful in estimating the probable future course of production in this country and competing countries, the demand for our durum both at home and in foreign markets, and prices to be realized for the crop.

RELATION BETWEEN WEATHER AND CROP YIELDS

Weather is universally recognized to have important effects on crop yields, and one of the projects of the division is to determine the relationships between weather and yields, so that weather reports can be used as a basis for estimating and forecasting crop production. Several aspects of the problem should be noted. In the first place, a knowledge of the influences of weather on yields is necessary if proper allowances are to be made for the uncontrollable elements in attempts to adjust production. Also weather-yield analyses furnish a valuable check on other information used in estimating production, and are one of the least costly types of information to be had for use in crop estimating. Next, it should

be noted that the full influence of given weather conditions may not become evident for a considerable period after they occur. A knowledge of their true influence, therefore, furnishes a basis for improving early forecasts of yields. In the case of precipitation it has been found that in parts of Canada fall rains influence soil moisture very greatly, and when they are inadequate the loss must be made up in the growing season or the crop will be damaged. The probabilities of their being offset by unusually heavy rains later can be calculated quite satisfactorily, so the study of precipitation and yields in such areas furnishes a very early forecast of probable yields. For other areas the supply of moisture is abundant and frequently excessive during the growing season, and for these areas it is necessary to recognize that a reduction of soil moisture one year is likely to show little or no effect on yields the next year. The need for such information in advising farmers on the outlook and in similar uses and the desirability of such analyses for the United States are obvious. But there are additional reasons for having such information for foreign countries. Foreign crop reports are characteristically unsatisfactory. In fact, some foreign countries do not even issue crop forecasts regularly, and some of the forecasts that are made are so unreliable that they can not be given serious consideration. Under these circumstances it is necessary for the United States Department of Agriculture to be ready to issue reliable information on the important foreign crops, and this can be accomplished best if the influence of weather on crop yields is understood.

In the last year additional attention has been given to the relation between weather conditions and crop yields, especially wheat. As these studies progress, bringing out the changing importance of various weather factors in determining yields with changes in geography, they tend to bring out more clearly the important factors and show where apparent correlation may be purely accidental. More complete weather data for Argentina, forwarded by the bureau's representative at Buenos Aires, are making possible more exhaustive studies for that country than have been possible previously. Further work recently done on relation of weather to wheat yields in western Canada is helping in attempting to evaluate probable Canadian wheat production under the unusual climatic conditions which have been prevailing this year. Progress is also being made on weather in relation to French wheat yields.

The division also cooperated with the Division of Crop and Livestock Estimates in studies of the relation of yields to weather conditions in the United States. From results to date it appears that sufficient study of this field could indicate to winter-wheat growers whether their yields are likely to be above average or below average before the wheat is planted, and by spring to give a reliable forecast of production.

THE LIVESTOCK INDUSTRY

The livestock industry was severely affected by the world-wide business depression, the drought, and the increased competition in foreign markets. At the beginning of the fiscal year livestock prices were declining at a rapid rate. Cattle prices began a downward trend in March, 1930, which continued almost without interruption until

the last of May, 1931, when prices were the lowest for that time of the year since 1911, and were 35 per cent under those for the same date in 1930.

The decline in hog prices was similar in magnitude to that in cattle prices. At the end of May they were also at the lowest levels in 20 years and were 40 per cent under those of a year earlier. Increased competition in foreign markets as a result of an expansion in hog production in the principal European hog-producing countries was an important element in the hog situation. Sheep prices were severely affected as a result not only of a reduced demand but also of a marked increase in production. At the end of May sheep prices were the lowest for that time of year since 1914.

These sharp declines in livestock prices, unprecedented except during the depression of 1920-21, necessitated considerable work during the year in analyzing the current situation as affected by the business depression, the drought, high temperature, and prevailing supplies, with the view of determining the most reliable indications of probable trends of production, market supplies, seasonal distribution of supplies, and prices. The abnormal conditions affecting the economics of the industries made it necessary, in addition to using the ordinary types of analysis, to study in detail the effects of other major business depressions, marked declines in the price level, periods of drought, and abnormal temperature on livestock production and prices. The results of these current studies were used in the preparation of outlook reports on hogs, cattle, and sheep and lambs, and in the preparation of a report entitled "The Reduced Feed Supply and Its Relation to the Livestock Outlook."

The monthly publication entitled "World Hog and Pork Prospects" was prepared and released about the 10th of each month. These reports contained an analysis of the most recent information on production, marketings, demand and prices of hogs and pork products in the United States and in all of the important hog-producing and pork-consuming countries.

POTATO PRICES

The work on potato prices consisted partly in preparing a manuscript for publication and partly in preparing three regional studies of potato prices and prospects for North Carolina, Maine, and Idaho. These studies of factors influencing potato prices and an analysis of the 1931 outlook in these regions were presented before farmers' meetings and published for wider distribution.

STATISTICAL RECORDS AND CALCULATIONS

One of the principal purposes of the division is to serve as a general source of statistical information on agriculture, and it gives attention to standards of accuracy in statistical research and statistical data. Because of these duties it is necessary for the division to keep up to date an ever-increasing number of statistical series and to assemble additional statistical information from time to time. The gradual growth in this work has been greatly emphasized by demands arising from the present depression.

TARIFF

The enactment of the 1930 tariff act has called for an increasing amount of attention to the tariff and agriculture. To meet the large number of requests on the changes of rates under the new act, a mimeographed bulletin was issued giving the tariff rates on agricultural products under the 1930 act as compared with those under the 1922 act. Prior to the enactment of the law the Members of Congress and others called upon the bureau for information indicating the extent to which various tariff rates might be effective on agricultural products and what responses American agriculture might make to various tariffs. For example, the division was called upon to prepare memoranda indicating the probable effect of a tariff on jute and the extent to which a tariff might be effective on long-staple cotton. Following the passage of the law, the bureau has been called upon to supply prices and import data and other information indicating whether the new rates that have been levied are effective. Such information has been asked for on practically all the important agricultural products of the country. Because of the detailed nature of the questions it has been found necessary for the division to study the influence of the tariff on each of the important agricultural products.

TRANSPORTATION

An increasing amount of work is being done on the relation of transportation facilities and costs to agriculture. Because of the importance of this work it has been necessary to follow in detail the investigations under the Hoch-Smith resolution and the rate cases before the Interstate Commerce Commission. A study was also made of the agricultural and transportation aspects of the milling-of-wheat-in-transit regulations for Kansas and Nebraska points.

Independent short and weak railroads receive special consideration in rate making. A study has been made of the extent to which this fact influences agriculture. It has been found that approximately 320,000 farmers are served by these lines, more nearly than by other roads. In these studies some attention has been given to the importance of this consideration to these short lines and their present financial and traffic problems.

The consolidation proposals of the Interstate Commerce Commission have been studied with respect to their influence on agriculture. For this purpose a series of maps has been prepared showing the consolidations proposed, thus indicating many effects which the formation of a system would have on the routing of and rates on farm commodities and suggesting the relative importance of the transportation economies involved. As an illustration of what this study shows, under current rules of rate making the inclusion of two now independent railroads in system No. 18 as proposed would wipe out the joint-line differential added to rates from Lamar, Okla., and reduce the charge on hogs to Oklahoma City by about \$9 per car.

Study is under way of the price comparisons for comparable grades of wheat in British and American markets in relation to transportation costs, since the theory rather generally stated that American

grain prices are made in Liverpool is recognized to be inadequate and in many cases misleading. To date this study indicates that a reduction of 4.2 cents per bushel in freight rates made by the South-western lines late in 1929 must be partly nominal during the summer months in its effect on prices. Studies of freight rates on western-bound livestock indicate a wide blanketing of rates from central-western Oregon as compared with a closer gradation with distances observable in rates from mountain-Pacific territory.

AGRICULTURAL HISTORY

As a basic work for members of the Department of Agriculture and students of agriculture generally, the division published a bibliography on the history of agriculture in the United States. It was assumed that this publication would be of interest only to technical workers, and therefore the edition of 5,000 copies was expected to supply requests for a period of 5 or 10 years. The demand for this publication has been so great, however, that the supply is practically exhausted seven months after its publication.

In addition to the general growth in the interest in agricultural history, the present depression has caused many to reexamine the developments in agriculture, both for the purpose of understanding our present situation and of discovering the responses that took place in agriculture following previous depressions. Adequate bibliographies greatly facilitate such work and lead to greater comprehension by students making such studies.

A mimeograph bulletin, George Washington and Agriculture; A Brief Note and Classified List of Annotated References, was published as a contribution to the bicentenary observance of Washington's birth to be held during 1932. Manuscripts have been prepared for bibliographies on American Indian agriculture and on the history of rice production in the United States. A bibliography is gradually being acquired on the history of agriculture in foreign countries, and these references are being made available to students through the current issues of Agricultural History. Articles and radio addresses were prepared on George Washington as a Farmer and Lincoln's Attitude Toward Farm Problems. As a part of the program of the Southeastern Economic Association at Atlanta, a member of the division presented a paper on The Historical Background of the Present Situation in Southern Agriculture.

DIVISION OF FOREIGN AGRICULTURAL SERVICE

ASHER HOBSON, in charge

Mr. Hobson resigned on August 31, 1931, to accept a position with the University of Wisconsin. L. A. Wheeler is now acting in charge of the division.

FOREIGN COMPETITION AND DEMAND

The foreign agricultural service is designed primarily to collect more accurate and more extended information upon world conditions regarding the production of, competition in, and market demand for agricultural commodities, with a view to furnishing a more reliable basis for production adjustments and marketing policies in the United States. To this end eight foreign field offices have been established. These are located at London, England; Berlin, Germany;

Marseille, France; Shanghai, China; Belgrade, Yugoslavia; Buenos Aires, Argentina; Pretoria, Union of South Africa; and Sydney, Australia, the latter four having been added during the last fiscal year. During the same period the number of commodity specialists was increased from one to eight.

Especial attention has been given by the Washington staff to the effective distribution of reports received from the field. The bureau's leased telegraph wires and market news service offices are being used to an increasing extent in disseminating current foreign news within the United States. This information is being coordinated with the periodic commodity reports issued by the bureau from Washington and the branch offices. Special arrangements have been made for the dissemination of crop and market information on fruits and nuts in the particular areas of the country producing these crops. By this means it has become possible to give increasingly prompt and efficient distribution to this important class of foreign information.

Other branches of the department, as well as the Department of Commerce and the Federal Farm Board, are supplied promptly with copies of the incoming cablegrams and reports in which they are interested. The content of the weekly publication *Foreign Crops and Markets* has been revised and its scope enlarged. Much information is received also by this office from offices of the Department of State, the Department of Commerce, and other Federal agencies. The number of commodities covered has been increased and emphasis is placed upon the prompt issuance of this publication.

LONDON OFFICE

The work of the London office in reporting current developments in the British market for American agricultural products has been continued and enlarged. Special cablegrams are being received on the London wool auctions and on the British consumption of wool which have an important bearing on the world wool-price level, and consequently upon the price of domestic wool in the United States. Regular cablegrams are furnished also on the British market for pork and pork products. Danish and colonial butter prices in the London market are cabled weekly.

In addition to the fruit specialist in the London office, the specialists on grain, wool, livestock, and meats, and one supervised by the Forest Service, giving attention to land utilization and forestry practices in European countries, have been added to the London staff.

The British apple import order, which prohibits the entrance of all but the higher grades of American apples during the period from July 1 to November 15 each year, gives added importance to the work of the fruit specialist attached to the London office. It has been necessary for him to make numerous inspections and certifications as to quality of American apples arriving in the British market. By means of these inspections it is possible to expedite the entry of large quantities of American apples.

Special reports were submitted by the fruit specialist on the effect of scald on export shipments and the means of preventing this condition, and also on the use of bushel baskets in apple exports. These reports were given immediate publicity in the apple-shipping dis-

tricts. This specialist continued the practice of writing individual letters to apple shippers in the United States, commenting on the condition of their fruit as he observed it on European markets. This service is much appreciated by apple shippers. Reports on market conditions for apples and pears were expanded and improved.

At the close of the fiscal year a new service was inaugurated to cover weekly market reports on the early deciduous fruit, such as plums, pears, and apples, shipped to European markets before the regular apple and pear season gets under way. This service was urgently requested by California fruit growers and shippers. Increased attention is being given to providing more comprehensive market reports on citrus fruit.

BERLIN OFFICE

The regular reports from the Berlin office on cotton, wheat, pork products, and fruit have been extended and improved. In these reports emphasis is placed upon the analyses of the demand for these products in the important consuming areas of northwestern Europe. The weekly cables of the Berlin office on Russian grain-crop developments and on European grain-market conditions are becoming recognized as a valuable source of information on these subjects.

The tobacco specialist attached to the Berlin office has submitted numerous reports on tobacco production in Europe and on the general demand conditions affecting the outlet for American tobacco on the Continent and in the United Kingdom. Special investigations have been conducted on the types of tobacco grown in Europe, and definite progress has been made on the classifications of European-grown tobacco in relation to their competitive significance to specific types of American tobacco. Other studies of the tobacco specialist have been directed toward the utilization of various types of tobacco in Europe and the trends and shifts in demand as between these types and American types.

BELGRADE OFFICE

The Belgrade office has developed a regular monthly report on wheat crop and market conditions in the Danubian countries. These countries constitute one of the important grain surplus producing areas of the world. Prospects for export from this region have a significant bearing on the world wheat-price situation. Special attention has been given to improvement of the statistical information on the supply of wheat, both production and stocks. With a sound foundation laid for grain-reporting activities, attention has now been turned to building up reports covering the production and marketing of other competitive products, such as fruit and pork.

MARSEILLE OFFICE

The Marseille office has made gratifying progress in the establishment of a comprehensive reporting service on the specialized fruit and nut crops of the Mediterranean Basin. Reports are being submitted monthly by mail and cable on almonds, walnuts, raisins, figs, and prunes. Preparations are under way for adding citrus fruits and olives to this list. Work is being done on the preparation of

reports along other lines, such as on wheat production and demand in the areas tributary to the office, on Mediterranean bean markets, and on general agrarian policy matters in southern European countries.

SHANGHAI OFFICE

The reporting work of the Shanghai office has been enlarged and extended. Reports are now submitted monthly on the demand for American cotton, wheat, and tobacco in the Orient. These include information on crop developments and results based to a considerable extent on personal observation. Definite statistical information on Chinese agricultural production is extremely limited. It is therefore especially important to have the best possible information of a general character on agricultural production in that country. The American consular officers, located in all parts of China and Japan, have rendered valuable assistance to the Shanghai office in giving a well-rounded picture of oriental crops and markets.

An outstanding accomplishment of the Shanghai office was the completion of a detailed report on regional agriculture in China. This report is based on extensive personal investigation and on the returns from questionnaires sent to missionaries throughout the agricultural regions. A summary of this report has been published and it is now being prepared for publication in its entirety.

PRETORIA OFFICE

During the few months of the fiscal year that the Pretoria office was in operation, basic reports were prepared and submitted on the wool, citrus-fruit, and tobacco industries of South Africa. In addition to the preparation of the special reports, a system of regular current reporting on fresh and dried deciduous fruits and citrus fruits has been developed. An example of these current reports is found in frequent cablegrams on the exports of fruit to Europe which serve to give advance information of significance to American exporters, who are also making shipments to the same markets.

BUENOS AIRES AND SYDNEY OFFICES

The offices at Buenos Aires and Sydney cover the most important agricultural areas of the Southern Hemisphere. Both of these offices have given especial attention to developing information on the acreage, production, and movement of wheat. The Argentine office has also covered flax. It is expected that during the next crop year more reliable information on wheat production and trade in the Southern Hemisphere will be made available. A start has been made toward the development of more timely and reliable information on wool and other products of interest to North American agriculture.

FOREIGN GOVERNMENT AGRICULTURAL POLICIES

Attention is being given to the collection and analysis of data concerning foreign government activities in behalf of agriculture. Because of the rapidly increasing number and variety of agrarian relief measures adopted within the last two years, the demand for information on this subject has grown to the point at which answer-

ing communications and preparing memoranda on current developments absorb a large part of the time of those in charge of this work.

The communications have dealt with such subjects as foreign tariff changes, countervailing duties, milling regulations, import-licensing systems, and various other types of import restriction; with export bounties and premiums, export monopolies, and other forms of regulation of exports; and with international agricultural conferences and agreements. Studies of these measures are carried beyond the mere assembling of the facts, into the realm of analysis and interpretation. The main activity of the section, in fact, is that of examining and appraising the effects of foreign governmental measures upon the interests of American agriculture.

A report has been prepared, for example, dealing with the significance to American farmers of recent Canadian tariff changes; another, with the proceedings of recent international wheat conferences. Manuscripts are approaching completion dealing with foreign government assistance to the raisin, currant, prune, and citrus industries.

A specialist on Russia has been added to the division's staff, in order that developments in this important competitive area may be followed more closely. In addition to following the current agricultural situation in Russia, special research is being conducted on the long-time aspects of Russian agriculture and their competitive significance to American agriculture.

DIVISION OF AGRICULTURAL FINANCE

ERIC ENGLUND, Assistant Chief of Bureau, in charge

AGRICULTURAL CREDIT

The credit work may be grouped under five subheads, as follows: Personal and Collateral Credit, Credit Corporations, Mortgage Credit, Emergency Credit Work, and Other Credit Studies and Activities.

PERSONAL AND COLLATERAL CREDIT

A project on current indices of deposits in country banks, as a measure of their ability to extend credit accommodations, has been continued. Through the cooperation of the Federal Reserve Board, data on country-bank deposits are now made available currently. One such index covers the deposits in 21 of the principal agricultural States, 1 covers the States of the Corn Belt only, 1 the States of the Cotton Belt, and 1 the Mountain States. These indices reveal clearly the relationship between credit supply in agricultural areas and the decline in agricultural commodity prices. This price decline, coupled last year with crop failure in certain States, reduced the flow of income into agricultural communities and lowered the level of bank deposits.

A comprehensive inquiry was undertaken which will provide information on the total volume of advances by banks to farmers in the United States. Similar information was published by the bureau for the years 1920 and 1923. The purpose of, security for, and risk on various classes of farm loans are also covered in this inquiry.

This and other studies now in process will be used to supplement information already on hand concerning credit conditions in the South and will make possible a more comprehensive presentation of these conditions and recommendations for their improvement.

An intensive study was made of the records of an Iowa country bank considered typical of a large group of successful banks in the Corn Belt area. Similar studies of other banks in this area will be made as rapidly as possible. Among the more significant results found may be mentioned the following: From 75 to 80 per cent of the bank's loans are made to farmers. The principal purposes of these loans are (1) to purchase livestock, (2) to pay for feed and other operating expenses, and (3) to pay existing mortgage indebtedness and to purchase real estate. These three purposes account for approximately 75 per cent of the loans.

Approximately one half of the new loans made are unsecured. The other half are secured by chattel mortgages and real-estate mortgages in the proportion of 5 to 2. Of the total loan operations each year, about 60 per cent represent new advances and 40 per cent are renewals of outstanding loans. The records indicate that the loans made for general expenses and feed are the most liquid. Naturally the real-estate loans are least liquid and cattle loans occupy an intermediate position in this respect. These records also indicate that renewals are decidedly less liquid than are new loans, these renewals representing more largely loans for the purchase of livestock and real estate. The loans outstanding at any time are relatively nonliquid, not more than 40 per cent being repaid within a period of 20 months.

The loan policy pursued by this bank, however, has proved highly successful and the bank is considered sound. Its deposits have remained stable and withdrawals have usually been coverable by cash reserve. The bank has seldom found it necessary to borrow from other banks.

The problems in financing the potato growers on the Eastern Shore of Virginia have been studied in cooperation with the Division of Farm Management. The results indicate that during the last three years growers bought approximately 85 per cent of their fertilizer for early potatoes "on time." Local dealers in turn purchased on time from 50 to 60 per cent of the fertilizer so used. Bank borrowings of the individual grower were relatively unimportant, the major reliance on credit in this area being represented by dealers' credit in the purchase of fertilizer.

CREDIT CORPORATIONS

Studies made of five agricultural credit corporations affiliated with cotton cooperatives showed that from the date of the first organization in 1924 until the close of 1930 these corporations had loaned \$41,000,000 to the members. Loans for 1930 were over \$8,000,000. Of 15 such corporations organized, however, only 6 are in active operation in 1931. The margin of earnings allowed the corporations in the past on their rediscounts with the Federal intermediate credit banks has in general been too small to cover expenses and absorb losses. The smallness of this margin of earnings has made itself

felt, particularly because of the very limited size of most of the loans, the relatively wide territorial distribution of these loans, the seasonal character of the business, and the heavy risk involved.

The studies of these corporations appear to indicate that the granting of production credit has no important bearing on the increase in membership of the marketing associations or the deliveries of cotton for marketing. At the present time, however, the credit corporations in many cases are rendering the members a much-needed service. The Division of Cooperative Marketing of the Federal Farm Board has cooperated in these studies.

Broader investigations carried on in connection with the more intensive study mentioned above show that agricultural credit corporations, including livestock loan companies, have increased rapidly in number during recent months. Whereas in August, 1930, the number of such corporations was only 245, the number in April, 1931, was 330. Many of the corporations in existence at the earlier of these dates have enlarged their capital with a view to expanding their services to the communities in which they operate,

MORTGAGE CREDIT

Efforts were continued to provide comprehensive current information on farm-mortgage conditions throughout the country. Periodical reports now received from mortgage bankers have proved of great assistance in this connection. These reports indicate that relatively short terms still predominate in the farm-mortgage loans made by institutions other than the Federal and joint-stock land banks, the average term being five years. These reports show also a tendency to restrict new loans to substantially smaller percentages of the value of farms than were permitted formerly, and requirements for annual installment payments have become more common. Supplementing the division's estimates of mortgage debt for 1928, other studies under way will give the basis for estimates of the amount and distribution of such debt for subsequent years.

Further attention was given to a study of the factors that have affected the marketability of Federal farm-loan securities, with particular attention to the problem of the earnings of the banks in the Federal farm loan system. The effects of the increased amount of real estate acquired and the depressed market values of joint-stock land-bank securities have been analyzed in relation to the salability of the bonds of the Federal land banks.

EMERGENCY CREDIT WORK

Much information on credit conditions was gathered in connection with the Federal drought-relief work. For most of the States in the officially designated drought region, separate indices of country bank deposits were prepared and supplied to those in charge of the relief work. One member of the staff acted as executive secretary to the National Advisory Loan Committee appointed by the Secretary of Agriculture to administer that part of the Federal drought relief available for capitalizing agricultural credit corporations. Detailed financial statements supplied by 44 new or existing agricultural credit corporations that applied for emergency credit were analyzed for the committee by another member of the division.

OTHER CREDIT STUDIES AND ACTIVITIES

The services of one member of the division have been loaned to the Federal Reserve Board for a part of the year to make a special study of the causes of bank failures and of other banking problems as related to agriculture. The large number of bank failures in farming districts during recent years makes such a study highly important.

At the request of the Pan American Union, cooperation was given to a committee appointed to consider the proposal for a Pan American agricultural credit bank. A report was prepared analyzing the economic problems involved in the proposal.

A study begun last year on the influence of central money-market changes upon the supply of agricultural credit for production purposes has been continued. A study on credit problems of Oklahoma cotton farmers was completed early in the year and the results published by the Oklahoma Agricultural College and Experiment Station.

Twelve articles on problems of agricultural credit and taxation have been prepared by the staff for the public press, and several radio talks on these subjects have been delivered. Two sections, covering farm-mortgage credit and farm taxation, were contributed to the Graphic Summary of American Agriculture published by the bureau.

AGRICULTURAL TAXATION

Four comprehensive research projects have been started in the field of agricultural taxation, as follows:

(1) The construction of a farm real-estate tax index, by States, for the years 1913 to 1930, inclusive.

(2) A study of the operation of the property tax in Louisiana in relation to agriculture. This study is being conducted in cooperation with the Louisiana Agricultural Experiment Station.

(3) A graphic presentation of some of the aspects of public finance in the southern Appalachian area. This is a part of a study undertaken by the Division of Land Economics.

(4) A study of the cost of local government in rural areas in Wisconsin in relation to farm taxation. This study is being conducted in cooperation with the Wisconsin Agricultural Experiment Station.

Special assistance was given to a subcommittee working under the advisory committee on social and economic research in agriculture of the Social Science Research Council in the preparation of reports on scope and method of research in farm taxation and in farm insurance. Six different research projects in credit were outlined by members of the staff for a credit subcommittee of the above-mentioned advisory committee.

AGRICULTURAL INSURANCE

A special study of fire losses on farms and means for reducing the number and amount of such losses was completed early in the year. The results were published as a joint contribution from this bureau, the Bureau of Chemistry and Soils, and the Bureau of Public Roads. This publication, entitled "Fire Safeguards for the Farm," deals in a nontechnical way with the threefold problem of (1) fire preven-

tion by safe construction, maintenance, and use; (2) individual fire protection by means of simple home equipment; and (3) rural group fire protection by means of community organization and motorized fire equipment. The bulletin has met with widespread demand, 41,000 copies being distributed before the end of the fiscal year.

Summaries of the business of farmers' mutual fire insurance companies indicate that these organizations are continuing to extend their operations and are insuring an increasing percentage of the farm property subject to loss by fire. The latest available comprehensive figures indicate that these companies, nearly 2,000 in number, now carry over \$11,000,000,000, of insurance, which is enough to cover to three-fourths of its value about 55 per cent of all the insurable farm property. Farmers' mutual insurance against the risks involved in the ownership and operation of automobiles has also made marked progress during recent years, particularly in the Middle West. Livestock insurance, according to information obtained, continues to decline in quantitative importance.

Plans for adapting hail insurance to meet more closely the farmer's real need for such protection were presented before an international association of State and municipal hail departments. Hail insurance continues to be the only form of crop insurance generally available to farmers. A new effort to provide a broader form of insurance on growing crops was, however, initiated in Kansas last spring. A summary of the various insurance needs of agriculture, the extent to which farmers now carry the different forms of insurance protection, and the existing facilities for such protection was prepared and presented before the annual conference of the American Institute of Cooperation.

DIVISION OF FARM POPULATION AND RURAL LIFE

C. J. GALPIN, in charge

The human factor in agriculture is becoming of greater importance. Various agencies, seeking to bring about a more balanced production of the major farm crops, work out plans for rationalizing acreage adjustments and then seek to present these plans to farmers in such a way as to obtain favorable action. As increased emphasis is placed upon planned production, the human factor in the situation will play a more important rôle. Nor is this confined to the individual farmer on his own farm. Local social control and the ideals of farm communities are being recognized by economists and by the public as facts and forces which must be taken into consideration in all agrarian policies. The problem is as much a sociological and psychological one as it is an economic one. The widely different work of those institutions, agencies, commissions, and private individuals who have sought information from the division concerning the human factor in agriculture gives ample evidence of the interest in the subject.

FARM POPULATION MOVEMENTS

Surveys of the movements of farm population have been continued. Each of the 10 years previous to 1930 showed a decrease in the total number of persons living on farms. It is likely, moreover, that this fact held good also for the previous 10 years, from 1920 back to 1910,

but data are not available on the subject. From 1920 to 1927 there was a decrease, year by year, of about 400,000 persons, while from 1927 to 1930 there was a yearly decrease of 200,000 persons.

The survey of farm population, made by the Bureau of Agricultural Economics, shows that the farm population during the year from January 1, 1930, to January 1, 1931, started to gain again, after losing ground for from 10 to 20 years. The bureau estimated that on January 1, 1931, the farm population was 27,430,000, as compared with 27,222,000 on January 1, 1930, a gain of 208,000.

The bureau's figures show that fewer persons left the farms for cities last year than in any year during the last 10 years. The number leaving the farms in 1922 was 2,000,000; in 1926, 2,155,000; in 1928, 1,923,000; in 1929, 1,876,000; but in 1930 it was 1,543,000. There has been a general though small decrease year by year in the number leaving the farms; but in 1930 there were 300,000 fewer persons leaving the farms than in the preceding year.

The movement of people from towns and cities back to farms last year was the largest in any year from 1924 to 1930. In 1924 it was 1,396,000. In 1930 it reached 1,392,000. Thus, while fewer people than usual left the farms to live in cities, at the same time more people went to the farms from cities.

COOPERATION WITH RURAL SOCIOLOGICAL EXTENSION PROGRAM

This division participated in a conference of extension rural sociologists called by the Extension Service. At this meeting a statement outlining the general objectives of extension work in this field and suggesting some specific lines of activity to be considered as part of an extension program was prepared. Permanent committees were appointed to study and report on needed research for an extension program and the assembling and adaptation of rural sociological material most helpful in an extension program.

FARMERS' ATTITUDE TOWARD ORGANIZATION

The study of membership problems of the Ohio Farm Bureau Federation and more or less related cooperative associations brought to light some highly significant facts. Among the leaders of the farm bureau was found a conception of what this organization is and what it has accomplished quite different from that existing among the rank and file of members and among other farmers who did not belong. Part of this discrepancy came from differences in emphasis of county farm bureau activity contrasted with more general and less easily seen activities of the State organization. Some of it was due to failure of farmers to keep themselves informed and some was due to the use of high-pressure salesmanship in the commercial activities of the organization. Local meetings were found to be the most successful and accurate means of spreading information, as well as an aid in the promotion of a wholesome, vitalized membership morale. Many other sociological findings of a highly practical nature came out of this study. In addition to the mimeographed reports already published, detailed reports for each of the 14 counties surveyed were prepared for the confidential use of the Ohio Farm Bureau Federation. State farm bureaus in several other

States have requested similar studies of their membership problems since the Ohio survey was made.

In April the division inaugurated another type of study in the Cotton Belt. This study proposes to find out the types of reasoning given by farmers in support of acreage shifts in cotton and other major cash crops; their behavior in response to price and other factors as indicated by changes in cotton acreages over the last six years; the extent to which these farmers receive and utilize or reject outlook information circulated by Federal and State agencies, and related problems. Answers are to be classified by tenure, experience as farm operator, schooling, average cotton acreage, extent of information on cotton markets, etc., to note any significant trends. The data are now in process of tabulation, and it is anticipated that a preliminary report will be ready by the next southern outlook conference in the fall of 1931.

The significance of this study lies in the importance being attached to rationalized control over production as proposed by the department's annual Outlook Reports and the evident need for further study of the human factor as a link of unknown potentiality in the chain connecting this outlook work with production activity on the individual farm.

DIVISION OF LAND ECONOMICS

L. C. GRAY, in charge

An unusually heavy demand has been made upon the Division of Land Economics for assistance and information on problems of land utilization and land valuation.

The division leader has taken part in many conferences, such as the convention of the chief appraisers of the Federal loan system, the meeting of the National Association of Real Estate Boards, and the International Conference of Agricultural Economists.

Addresses prepared on such subjects as the National Land Policy in Retrospect and Prospect, Responsibility of Overproduction for Agricultural Depression, Factors to be Considered in Forecasting Land Values, and others have been published in the proceedings of various economic associations. Much attention has been given to the preparation of information on specific phases of the national land policy, including analysis and recommendations for changes in pending bills submitted to the department for criticism.

LAND-SETTLEMENT STUDIES

Many inquiries concerning opportunities to purchase farms and farm lands and to establish various colonization and land-settlement plans in different parts of the country reach this office. As a basis for effectively handling such correspondence with prospective purchasers of land, land-selling agencies, and others interested in land settlement, a record of privately owned lands available for settlement is being kept, together with miscellaneous information concerning the practices of land-selling agencies.

A report entitled "Economic Aspects of Land Settlement in the Cut-over Regions of the Great Lakes States" has been published. This report is designed to supply information to persons contemplating settlement and to land-selling agencies and others interested in

the development of the region. A paper entitled "State Policies in Regulating Land-Settlement Activities" was prepared and read at the twenty-first annual meeting of the American Farm Economic Association, held in Cleveland, Ohio.

Work has been started on a study of land-settlement opportunities, problems, and policies in the United States for the purpose of helping land-selling agencies, public officials, and others to formulate sound policies with respect to land settlement and to help prospective farmers get acquainted with existing policies in the various States. Assistance has been given to officials of the Brazos Valley Water Users' Association and to a Georgia State committee on land-utilization projects.

LAND TENURE

The increasing importance of farm tenancy has led to an analysis of the subject on the basis of census statistics from the 1925 census in comparison with earlier censuses. Tenant-operated farms were 25.6 per cent of all farms in 1880 and 38.6 per cent in 1925. The value of all farm property, including real estate, used by tenants has not been reported at all periods, but it increased from 27.5 per cent in 1900 to 34.9 per cent in 1920.

The importance of tenancy is further emphasized by the fact that a large proportion of our staple crops is grown on tenant farms. In 1924 tenants produced 46 per cent of the corn, 38 per cent of the wheat, 67 per cent of the cotton, and 48 per cent of the tobacco. Since many tenants are less free to change their farming systems than are owners, the large proportion of tenants must be considered in all plans for better marketing and better adapted production.

The large increase of 74 per cent in the period from 1880 to 1925 in the number of tenant farms over 50 acres in size is significant, because in this group we find the most of our so-called family farms. Relatively the small tenant farms have increased much less rapidly. The tenant farms of 1,000 acres or more in size are mainly devoted to livestock production.

All this work is being kept up to date and used as a basis for planning and carrying out more detailed investigations concerning the problems of adjustment between landlords and tenants in areas where conditions are rapidly changing as to lines of production, technical methods, prices, and costs.

FARM LABOR

During the year a bulletin entitled "Perquisites and Wages of Hired Farm Laborers" was published. This gives extensive detailed data supplementing the department's periodical reports on farm wages by showing the variety, frequency, amounts, and values of the perquisites received by hired farm laborers, both casual and non-casual, in addition to money wages. It also makes a comparison of the average quantity and value of farm perquisites with the average city family purchases of similar commodities or services. Estimates made show that the total remuneration of noncasual hired farm labor equals or exceeds that of corresponding classes of labor in other specified occupations.

In June, 1931, a representative of this project was called upon in connection with the President's Conference on Home Building and

Home Ownership to serve on the committee on rural and village housing. The purpose of the work will be to assemble and study existing literature on the housing of special groups of rural population and to make recommendations for further research concerning housing problems affected by and affecting social and economic welfare of the special groups and their relationship to other elements of the population.

THE PUBLIC DOMAIN

Studies of the factors that affect the use of the public domain have been in progress in this division since it was established. A special study of conditions in Nevada has been completed and a manuscript covering the work has been prepared. At the request of a member of the Committee on the Conservation and Administration of the Public Domain, appointed over a year ago by President Hoover, copies of colored maps that picture relationships of legal tenure, range claims, existing and possible use, and control of all the lands of Nevada were made available to the commission in advance of publication.

These maps superimpose the land-tenure pattern upon the physical potentialities of the State. They show the distribution and uses of private and public lands as well as the complicated interdependence of lands having longer or shorter seasonal or otherwise restricted uses. One of them shows something of the complicated and competitive nature of claims now made by stockmen to grazing rights on public lands and the privately owned lands with which these public lands are necessarily associated.

Data for a similar study of the five northwestern counties of Colorado have been obtained, and this information is now being compiled and transferred to maps which will picture the physical, economic, and other conditions of the region. The region selected is one in which considerable agricultural development is possible and likely to occur in the not distant future as the result of improved railroad facilities due to the construction of the Moffat Tunnel.

LAND RESOURCES AND LAND UTILIZATION

The third revision of the Graphic Summary of American Agriculture, a compilation of 350 maps and graphs, with accompanying captions and text based mostly on the 1925 census of agriculture and on the annual estimates of crops and livestock made by the Bureau of Agricultural Economics, was published. Previous editions of this Graphic Summary have been widely used by all classes of agricultural workers, as well as by the general public. They have also provided from a fourth to a half of the illustrations in the various elementary and college textbooks on geography published since the World War, and the publication has been extensively used in departments of instruction in the agricultural colleges and in many State universities.

The soils section of the Atlas of American Agriculture was also prepared for publication. Part of the work in preparing the maps was done by geographers of this division, but the bulk of the work was carried on in the Bureau of Chemistry and Soils. This is much the largest section of the atlas to be issued. It summarizes the work of the Soil Survey during the past quarter of a century. With the

completion of the soils section the atlas will be ready for publication in a single volume. This atlas is the main source of information on the physical basis of American agriculture for agricultural experiment station workers, geographers, and other scientists.

Addresses were given and published on the long-time outlook for agriculture in relation to land utilization, population trends in relation to land utilization, and other phases of the land-utilization situation. In addition, work was started on the preparation of an article dealing with the social significance of land resources, to be used by the President's committee on recent social trends.

LOCAL LAND UTILIZATION AND REGIONAL PLANNING STUDIES

A study of land utilization in Knott County, Ky., was undertaken in cooperation with the Kentucky Agricultural Experiment Station, the Bureau of Home Economics, the Forest Service, and several divisions of this bureau. The manuscript for a publication entitled "Forestry in the Economic Life of Knott County, Ky.," is being reviewed for publication by the University of Kentucky. Three special reports, relating, respectively, to farm management, family living, and community organization, will be published.

A manuscript entitled "Land Utilization in Laurel County, Ky.," has been prepared for publication as a technical bulletin. The field work on which this manuscript was based was conducted in cooperation with the Kentucky Agricultural Experiment Station.

The study of land utilization in Nicholas and Webster Counties, W. Va., in cooperation with the Forest Service of the United States Department of Agriculture and with the West Virginia Agricultural Experiment Station, has been completed and a report submitted for publication. Recommendations are made for the classification of a part of the land as adapted to agriculture and another large part as being best suited to forestry. A small area is classified as being doubtful for agricultural use. It is believed that this general classification will be of service to extension workers and civic leaders in planning the agricultural and forestry program in similar counties.

The study, "Land Utilization and Farm Management in Wyoming County, Pa.," has been completed and the results have been published as a bulletin of the Pennsylvania Agricultural Experiment Station.

The results of a field study in Tioga County, Pa., will be published in two parts, one dealing with the farm-management aspects of the problem and the other with land utilization. These studies show that there are considerable areas in both counties that are distinctly nonagricultural and best used for forest and recreation purposes. The concentration of farming in the areas best suited for the purpose will eliminate wasted effort on the part of individual farmers and enable the political units to plan school and road-building programs on a sound basis.

Extensive preliminary planning has been done in preparation for an economic and social study of the southern Appalachians, in cooperation with the Forest Service, Bureau of Home Economics, the Department of the Interior, several State experiment stations, and other divisions of this bureau.

LAND APPRAISAL AND LAND VALUES

The fourth annual nation-wide survey of the farm real estate situation has been published. The investigation disclosed that, although land values generally continued the downward trend of the past several years, the average value per acre of farm real estate for the United States as a whole declined only one point in the bureau's index for the year ended March 1, 1930. This decrease may be compared with decreases of 1 per cent in 1929, 2 per cent in 1928, 5 per cent in 1927, and 3 per cent in 1926. For the Nation as a whole the average value of the farm real estate was 15 per cent above its pre-war average. At the peak of the boom in 1920 values were 70 per cent above pre-war.

Measured in dollars of the purchasing power of 1910-1914, values on March 1, 1930, were approximately 15 per cent below the pre-war levels. The average number of forced sales per thousand farms was 20.8 for the year ended March 15, 1930, a slight increase over the rate for the preceding year. The 1930 figure interrupted the downward trend in forced sales which had obtained from 1927 through 1929. The increase in forced sales was manifested both in number of farms sold for delinquent taxes and in those sold as a result of foreclosure on mortgages, bankruptcies, and other defaults. The report further stated that the demand for farms continued light, such purchases as actually occurred apparently being made by farmers buying for actual operation.

The fifth nation-wide survey is well under way. A preliminary report issued in May indicated that, as a result of the very unfavorable year, land values for the year ended March 1, 1931, had experienced the greatest declines since 1922, the average for the United States having dropped 8 per cent during the year, to a point only 6 per cent above the 1910-1914 average. On March 1, according to the report, land values in 15 States were below pre-war levels, and the indications were that the tax and foreclosure situation is not clearing. The experiment stations of several States have requested cooperation in making intensive studies of the value structure of the farm real-estate market in their respective States. Several States planning to hold land-valuation short courses have extended invitations to representatives of this division to give talks on land values or related subjects.

VALUATION OF LANDS IN THE MISSISSIPPI VALLEY

The work of appraising agricultural lands in the lower Mississippi Valley in connection with the flood-relief program of the War Department was continued during the past year in cooperation with other bureaus of the department. A report was submitted to the War Department, February 1, 1931, covering over 700,000 acres of agricultural land, which accounted for almost one-half the value of the real property covered in the appraisal. Further appraisal work is being carried on for the War Department in the Birds Point-New Madrid floodway in southeast Missouri. This involves the valuation of flowage rights on the lands which are to be subject to overflow in the operation of the floodway.

SMELTER-FUMES INVESTIGATIONS

A special study of the economic damage of smelter fumes in the valley of the Columbia River of northeastern Washington has been conducted at the request of the State Department on the basis of funds transferred from that department. It is being carried on in cooperation with the Bureau of Chemistry and Soils and the Bureau of Plant Industry. So far as is known, this is the first study made by economists on the effect of smelter fumes on farm-land values and the farm business as a whole. The preliminary report on this study is practically complete and indicates the great complexity of the nature of economic damage to agriculture and forestry by smelter fumes.

TOBACCO SECTION

CHARLES E. GAGE, in charge

The Tobacco Section has completed its second year and has made encouraging progress, notwithstanding the adverse conditions under which it has operated, resulting from unusually low prices paid to tobacco growers. The major project of this new unit of the Bureau of Agricultural Economics is the inspection and certification of grade on leaf tobacco by tobacco graders under Federal-State appointment. Inspection service was supplied at 96 auction warehouses and 27 cooperative association receiving stations during the year, compared with 22 auction warehouses and no cooperative receiving stations during the preceding fiscal year. In addition, a beginning has been made in the inspection and certification of tobacco for export trade.

The total amount of tobacco officially graded during the last fiscal year was 48,155,791 pounds, compared with 11,741,636 pounds graded during the preceding year. The Tobacco Section is now providing grading service for two cooperative associations of tobacco growers, one in South Carolina and one in Wisconsin.

A qualified tobacco expert has been employed to develop technical knowledge of the physical characteristics of leaf tobacco with particular reference to standard grades. It is expected, too, that this work will yield important results in accurately defining standard grades and making it possible to maintain them unchanged from year to year. The staff has been further increased by the appointment of a specialist in cigar tobacco, who supervises the grading activities on cigar types and studies the marketing problems of cigar-tobacco-producing districts.

The second major project of the Tobacco Section pertains to the quarterly reports of stocks of leaf tobacco in the hands of dealers and manufacturers. The handling of these reports has been reduced to a routine procedure. Contact is maintained with members of the tobacco trade and their cooperation obtained in maintaining the accuracy of the reports.

COLD-STORAGE STATISTICS

WILLIAM BROXTON, in charge

During the year the Cold Storage Section undertook the compilation of a monthly report on the manufacture of oleomargarine. The biennial survey of refrigerated warehouse space was issued, as well as a biennial bulletin on cold-storage holdings and refrigerated warehouse space. At the request of members of the cold-storage industry a list of all of the concerns reporting cold-storage holdings was prepared for publication. All of the periodic reports on the various commodities held in cold storage were continued as in the past.

ECONOMIC LIBRARY

MARY G. LACY, in charge

The services of the library were in greater demand than ever before. Reference work was heavy and varied. The topics upon which information was most often requested were wheat, the tariff, farm income, and wages. The work of preparing bibliographies covering the literature on the economics of production and marketing was continued. These bibliographies are in constant demand, and research workers state that they are invaluable to them.

The mailing list for the monthly publication *Agricultural Economics Literature* has grown steadily and, judging from the comments received from users, it appears to be meeting a need in keeping agricultural workers in touch with the latest additions to agricultural economic thought.

There was an increase of 13 per cent in the number of letters dictated in the library, although form letters were used wherever possible.

DIVISION OF ECONOMIC INFORMATION

J. CLYDE MARQUIS, in charge

The rapid expansion of the use of economic information by farmers is shown strikingly by the steady growth of demand for bureau publications. These continue to increase both in numbers and varieties. The bureau's work in research and service now covers many new subjects, each of which involves some type of a report. While requests were formerly for dozens of copies, the reports are now asked for by the hundred.

The expansion of Federal and State extension agencies in organizing and developing agricultural economic work has provided an outlet for all types of information. These workers need material as a background for current work and for training as well as for extension.

The teachers of vocational agriculture in rural high schools have been directed by the Federal Board for Vocational Education to include economic subjects. They have become particularly interested in the outlook work, and arrangements were made to send copies of all bureau publications bearing upon the agricultural outlook to the entire group of these teachers. The head of the Division of Economic Information appeared before State conferences of these teachers to explain the character and scope of the bureau's publications and to give suggestions regarding their use in teaching work.

NEW OUTLOOK PUBLICATIONS

To meet the need for comprehensive understanding of the situation with respect to certain major crops, several bulletins of a new type were issued during the year. These included the following: The World Wheat Outlook and Facts That Farmers Should Consider, Miscellaneous Publication 95; World Cotton Situation, Miscellaneous Publication 104; and The Outlook for the Dairy Industry, Miscellaneous Publication 124. Altogether these publications were printed in editions exceeding 325,000 copies. For the first time a popular edition of the Outlook Report was issued for the direct use of farmers; the edition was 225,000. A meeting to formulate the outlook for the Southern States was held in advance of the regular meeting, that the material might be available in time for southern plantings, and a separate report was printed for southern use. The edition was 105,000.

These publications represent the type of background discussions that are being prepared to cover most of the major crops and classes of livestock. They represent a summary of economic information not heretofore available. Text, statistics, and liberal use of charts make them useful as teaching aids.

Exhibits have been prepared for four of the regional outlook conferences to show publications that are available and how they are related to each other.

NEW CURRENT PUBLICATIONS

A number of current publications of special interest to the dairy industry have been started. These include a monthly mimeographed report on Milk Production Trends, which presents the results of crop estimates reports on milk production and carries this information to farmers who are reporting on this subject. A Statistical Supplement on Milk Production is being issued for technical workers, crop statisticians, and others. A series of monthly World Survey Reports dealing with butter was begun. These special reports, together with what has previously been issued, make possible a much more comprehensive presentation of the facts on the dairy industry than has heretofore been available.

The issuance of information in the form of mimeographed reports for immediate use continues to expand. Over 225 mimeograph reports were handled during the past year. The editions of these ranged from a few hundred to several thousand, making a total of about 350,000 copies. These are distributed chiefly to specialists, extension workers, teachers, and research workers. By this method the results of research are made available promptly.

PRINTED PUBLICATIONS

The bureau contributed 48 publications to the regular department series of publications, 15 manuscripts were being prepared for publication at the end of the year, and a number of preliminary reports were issued.

There was an increase in the number of articles prepared by members of the technical staff for outside publication. The number of radio talks given exceeded that of any previous year.

RELEASES TO THE PRESS

The bureau organization has continued to increase its contacts with newspapers and farm papers. During this period, when the press has had difficult conditions to meet, the opportunity to secure the publication of official information has been unusually good. Every effort has been made to meet all requests from editors with suitable releases or special articles.

Special market articles are prepared for about 65 publications, such as leading farm papers and rural editions of important newspapers, which have an aggregate circulation of between 9,000,000 and 10,000,000. In this service, about 15 different regular weekly articles are prepared and 5 monthly features, and copies are distributed by leased wire or mail to reach the publications exactly at closing date. Each is prepared to include as much material as possible of interest to farmers in the region covered by the periodical using it. Comments from editors have been universally enthusiastic.

MARKET NEWS BY RADIO

The dissemination of market information by radio is now regarded by a large number of producers as essential to good marketing. Radio market news has become stabilized during the past year or two, and it appears to be less subject to change than it was in the early stages. The principal service to growers and shippers is through the release of market reports from various branch offices of the market news system to the local radio stations. By this means market information bearing on the truck crops that the producers are shipping reaches them promptly. Such releases, covering cotton, grains, fruits and vegetables, dairy and poultry products, and livestock, meats, and wool, are being broadcast regularly to more than 100 stations.

Supplementing the current price information, principally of local origin, the chain broadcasting program of the bureau furnishes a general situation review which is of much practical value to farmers. This chain program now covers the country. The broadcasting from the national chain at Washington has been supplemented by that from a chain originating at San Francisco and covering the Pacific and Mountain States. On this chain there are now regular monthly reviews covering principal crops and livestock, as well as special broadcasts on conditions through the season. These reviews have been pronounced of particular value by extension workers as a supplement to their work on the outlook, marketing, and farm management. The bureau furnishes a large proportion of the talks and the speakers in this service.

The department Radio Service manuscripts for broadcasting by local stations have provided an outlet for an increased volume of timely material. This information is used by about 40 stations. The bureau has contributed about 50 talks and lectures to this series. During the year an unusual number of emergency discussions were added, dealing with the drought and crop-adjustment campaigns.

NEW ECONOMIC EXHIBITS

The exhibit work of the bureau was expanded during the year. A special bureau display on wool utilization was built and was shown at a number of large fairs, expositions, and sheep raisers' conventions in the principal wool-producing territories. This created such favorable comment that a department exhibit was planned and constructed, to be used during the forthcoming season. For the first time the department has a comprehensive display relating to sheep and wool, including several units which present distinctly economic information dealing with the outlook, grades of wool, and wool utilization.

A department committee was appointed to prepare a similar departmental display relating to cotton, and the bureau has made plans for several economic units in this series.

To supply a need for a light portable type of demonstration material to be used at small conventions, the series of portfolios which may be shipped by parcel post has been expanded by the addition of new collections covering fruits and vegetables, dressed poultry, meats, etc. These portfolios are used on occasions where the larger departmental exhibits can not be handled.

Bureau representatives assisted in the presentation of exhibits at about 12 important fairs and expositions in cooperation with the department Office of Exhibits. The bureau also prepared displays for the International Livestock Exposition, National Dairy Exposition, the Textile Show, and the State fair circuits.

ECONOMIC-CHART SERVICE

With the rapid expansion of extension work in agricultural economics, the demand for charts for extension work has continued to expand. The series of outlook-chart books have been revised and reissued and a total of 5,300 copies has been distributed to outlook workers.

The use of wall charts 30 by 40 inches has also been greatly extended. Over 1,800 charts of this sort have been made and sold at cost to extension workers and others. One special edition of 1,200 charts was prepared for use in the cotton-outlook campaign in the Southern States. Through reproduction by rotaprint, thousands of prints of charts have been used in various bureau releases and in special publications for extension work.

MARKET LEGISLATION SERVICE

In cooperation with the National Association of Marketing Officials the market legislation service has been continued. Reviews of current changes in State and Federal laws have been prepared for publication weekly in the mimeographed periodical *Marketing Activities* and upon special requests of various officials. A summary of market legislation was prepared for presentation at the annual meeting of this organization.

Ag 84
NOV 25 1931

U. S. DEPARTMENT OF AGRICULTURE

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., August 31, 1931.

SIR: I present herewith the report of the Bureau of Animal Industry for the fiscal year ended June 30, 1931.

Respectfully,

J. R. MOHLER,
Chief of Bureau.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

IMPORTANT FEATURES OF THE YEAR'S WORK

Although the year covered by this report was marked by low-price levels for domestic animals and their products, certain other conditions affecting the livestock industry were highly encouraging and beneficial.

Experiments and research work were fruitful of results, many of which have direct practical application. Dependable information on methods of breeding, feeding, and caring for livestock is more abundant than ever before; diseases and pests are under better control; and the various branches of the industry are aiding one another in their problems in a most commendable manner.

The veterinary situation was improved by a material increase in enrollment in the veterinary colleges after a period of several years during which the number of graduates from those institutions was inadequate for the best interests of official work and the livestock industry.

This report presents briefly the results of the bureau's work having general public interest. Scientific studies requiring detailed discussions of methods and data, for clear understanding, are presented in technical bulletins and in the department's *Journal of Agricultural Research*. In addition to work discussed in this report, the bureau is also conducting numerous projects that have not advanced sufficiently far to justify statements of results at this time.

ANIMAL HUSBANDRY INVESTIGATIONS

In the field of animal husbandry the bureau has continued to search for the most efficient production methods compatible with the kind and quality of the finished product desired by consumers. A noteworthy feature of these investigations is the high degree of cooperative effort which has been built up with other bureaus of the depart-

ment, with State agricultural colleges and experiment stations, and with various other scientific organizations in the solution of the problems confronting the livestock and meat industry. This widespread cooperation has not only succeeded in hastening progress and in making results more comprehensive, but through pooling of efforts and resources has also effected real economy.

An outstanding example of this cooperation is the extensive study of factors which influence the quality of meat, a project which is being conducted in cooperation with the Bureaus of Agricultural Economics and Home Economics of the department and 22 State agricultural experiment stations. In one phase of this investigation during the year, rapid gain in swine was found to improve the palatability of the resulting meat.

Breed comparisons thus far have failed to show marked differences in the palatability of the cooked meat. However, striking variations have been found in both the composition and palatability of the meat from individual animals within the same breed. This lends encouragement to the efforts of the bureau, through a series of carefully planned performance studies now in progress, to identify and further improve superior families or strains of meat animals within a breed.

In areas of the South recently released from cattle-tick quarantine, investigations in beef-cattle production and related problems were begun. This work has already resulted in greater production of feed crops suitable for beef-cattle feeding, increased numbers of cattle fattened on grain, the production of higher-quality meat in many localities, and a marked increase in the number of purebred beef bulls being used in this region.

So much of the success of beef-cattle production on ranges depends on the percentage of calf crop obtained that any management practice which will increase it is of importance to the producer. Range studies in Colorado and Wyoming made in cooperation with the Bureau of Agricultural Economics and the State agricultural experiment stations show that materially better calf crops are obtained from pasture breeding than from breeding on the open range or forest reserve.

The value of flushing (the practice of giving ewes extra feed at breeding time to increase the lamb crop) has been well established in a series of investigations, as has also the superiority of good pasture over other feeds for this purpose. During the year ewes flushed on extra good pasture produced 164 lambs per 100 ewes, whereas those flushed on grain produced only 152 lambs per 100 ewes, and those not receiving any extra feed at breeding time produced only 143 lambs per 100 ewes.

Extensive studies in swine breeding have furnished data showing that, contrary to common belief, crossbred animals are not always of greater vigor than purebreds, nor do the crossbreds always make superior gains. Swine investigations likewise showed that fertility in the breeding stock, together with low mortality, appears to be more important than small differences in the type of animals and in rates of gain.

In the growing of market hogs, it has long been considered most economical to feed them all they will eat in order to bring them to desired weight as rapidly as possible. Studies on the economy of gains in hogs fed at different nutritive levels, however, indicate that

the lower levels are more economical for pork production than the established practice of full feeding. Pigs fed the limited rations proved more efficient in the utilization of their feed than did those fed a full ration, requiring much less feed per 100 pounds of gain and producing somewhat leaner carcasses. On the other hand, the pigs fed on restricted rations made slightly less rapid gains and required somewhat longer feeding periods to reach similar weights. These results indicate that the limited feeding of swine may be a practical and efficient method of reducing pork-production costs when the labor cost and market situation are favorable, or when a predominance of leaner cuts of pork is desired.

A study of the effect of egg production on hatchability has shown that, contrary to general opinion, a large production of eggs during the breeding season is apparently conducive to good hatchability.

FEDERAL MEAT INSPECTION

The Federal meat-inspection service continues to conduct its operations on a vast scale and in accordance with high professional standards. During the year more than 74,000,000 animals and the meat derived from them passed under the scrutiny of Federal inspectors. The service insures the healthfulness, soundness, and fitness of this food for the American people and those in foreign countries who consume our exported meat food products. Mention of Federal meat inspection is now being frequently made as a part of advertisements of inspected establishments and on menu cards. Thus an activity which is chiefly of a regulatory character is receiving a high degree of cooperation from the food trades.

It is gratifying to report also that the principles and methods used in Federal meat inspection are being followed to a noteworthy extent by States and municipalities in drafting laws and ordinances governing intrastate and local meat inspection.

TUBERCULOSIS ERADICATION

The eradication of tuberculosis from cattle proceeded rapidly during the year and exceeded all former years in volume of testing. Two additional States—Michigan and Indiana—completed the testing of their entire areas and were officially designated as modified accredited areas, signifying the practical freedom of their cattle herds from tuberculosis. This achievement, added to the accreditation of North Carolina and Maine, previously reported, gives further convincing proof of the effectiveness of the methods being used to eradicate the disease.

Favorable public sentiment has been largely responsible for the successful progress made. Opposition to the work, though lately only of sporadic nature, was reduced further by several important court decisions rendered during the year. The accreditation of Michigan followed closely a decision of a circuit judge in that State sustaining the right of public authority to test, condemn, appraise, and slaughter privately owned cattle in the campaign to eradicate bovine tuberculosis. A decision of the Supreme Court of Iowa likewise was beneficial in advancing tuberculin testing in that State. The decision upheld the reliability and value of the test and the view that bovine tuberculosis is transmissible to human beings.

An added development in the systematic attack on tuberculosis of livestock was the formulation of plans for combating more aggressively the avian type of the disease which affects both poultry and swine.

TICK ERADICATION

The eradication of cattle ticks, which formerly infested 15 Southern States, continued to make substantial gains. With the release of all of Mississippi at the beginning of the fiscal year, the number of States still under quarantine was reduced to four, namely, Arkansas, Florida, Louisiana, and Texas. Notwithstanding many physical obstacles and some scattered opposition, tick eradication is now receiving the support of the great majority of progressive livestock owners and public officials.

Improved breeding stock of both beef and dairy types is steadily being introduced in areas freed of ticks with resulting improvement in herds. Interest in the breeding and feeding of such herds has resulted in many requests for assistance in the selection and introduction of breeding stock. In cooperation with the State extension service and through its own specialists, the bureau has endeavored to meet this new responsibility.

INFECTIOUS ABORTION

The continued need for simpler, better, and more uniform methods of combating infectious abortion has caused this problem to receive major attention in research activities. Studies by the bureau independently and in cooperation with eight State universities and experiment stations have thrown new light on several phases of the malady and its control. Special attention was given to the use of strains of *Brucella abortus* of reduced virulence as possible immunizing agents against infectious abortion. The results encourage the belief that a reasonably effective method of vaccination may be developed, through the use of such strains, for combating the disease in herds where control by the segregation and elimination methods is impracticable. Further investigation of modes of infection yielded additional data to strengthen the suggestion made last year that the eye and skin are probably important routes of infection.

Technical studies of the agglutination test, as well as the experience gained through testing thousands of blood samples, have led to refinements in technic and improvements in the interpretations of results. In addition to this class of investigations, results of other studies continue to warn against unfounded claims, especially those involving the purchase of alleged medicinal remedies for infectious abortion. Tests of several chemical preparations for the treatment of the disease, especially as means for freeing the udders of infected cows from *Br. abortus*, gave no indication of effectiveness.

SIMPLIFIED TEST FOR PULLORUM DISEASE

Research to devise more effective means of combating pullorum disease in poultry flocks was conducted during the year. Bureau scientists were successful in making improvements on former methods, the results indicating that testing of flocks can be materially hastened as well as simplified. The essential step in the improved

method is the use of a stained antigen as the diagnostic agent. When mixed with a fresh drop of blood on a pane of glass, the stained antigen gives a quick and clearly visible reaction if the disease is present. Besides its simplicity and adaptability for field use, the improved test is much less expensive than the tube method, which involves considerable laboratory equipment. The improved form of antigen has been widely distributed to investigators throughout the country. Results thus far are highly favorable, showing close agreement between the results of the simplified test and those obtained by the laboratory method.

ANIMAL-PARASITE INVESTIGATIONS

In an effort to reduce livestock losses caused by animal parasites, the bureau's work has followed two principal lines: (1) Scientific research on the life cycles of parasites as a basis for instituting preventive measures; and (2) the investigation of remedies for treating infested stock. The year's work led to new knowledge concerning the mode of transmission of important parasites such as kidney worms, nodular worms, and lung worms of swine, and of various species of roundworms and tapeworms of poultry. These findings supplement the successful outcome of previous investigations on which are based the present successful campaigns against roundworms in swine and liver flukes in sheep.

The methods used in these campaigns have enabled stock raisers to reestablish their herds and flocks on a healthy basis, after periods of serious loss and discouragement because of previous inability to find the obscure cause. Producers who follow parasite-control methods carefully are raising their stock with greater economy and success than formerly, whereas others in the same locality who still use old methods of production continue to suffer losses or obtain low returns on their investment.

In California, where liver-fluke disease in sheep is now being successfully prevented by the destruction of snails on pastures and by medicinal treatment of affected animals, sheep raising has been restored to a safe industry. The liver-fluke-control work has also effected material saving in feed and prepared the way for more economical lamb production. The net result has caused the enterprise to be now considered stable security for loans by banks.

LIVESTOCK IMPROVEMENT

As in former years, the bureau continued to lay stress on the importance of breeding improved types of livestock. The number of livestock owners participating in a systematic campaign to that end reached a total enrollment of 17,555 at the end of the year. Although this activity is intended principally to encourage the use of purebred sires, it is noteworthy that there has been improvement in dams, also. The records of the campaign show that for every purebred sire which the average participant owns, he has 6 purebred females, 2 crossbred females, 9 grade females, and 0.4 scrub female. The ratio of 6 purebred dams to every purebred sire is evidence that owners who begin the improvement of their livestock by introducing purebred males soon acquire purebred females to hasten the rate of progress.

VETERINARY EDUCATION

The status of veterinary education continues to have a significant bearing on the bureau's work and on the livestock industry. During the year encouraging increases were noted in the number of graduates and in student enrollment at the accredited veterinary colleges. The number of graduates during the year was 210, an increase of 43 over that of the preceding year. The registration of freshmen increased from 347 to 436, and the total attendance in all classes increased from 1,055 to 1,225. In the last five years the student enrollment in veterinary colleges has more than doubled. These figures show a distinct advance of interest among young men in preparing themselves for the veterinary profession.

The total number of accredited veterinary colleges in the United States remains at 12. Recognized foreign veterinary institutions increased during the year from 10 to 11, through the addition of the School of Veterinary Medicine, Ghiza, Cairo, Egypt.

PERSONNEL

On July 1, 1930, the bureau rolls showed 4,307 employees of all grades and designations in Washington and in the field. During the year 818 were added to the rolls, 768 by appointment or reappointment, 26 by transfer from other bureaus or departments, and 24 by reinstatement. During the same period 79 employees resigned, 37 died, 29 were transferred to other bureaus or departments, 115 were retired under the amended retirement act of May 29, 1930, and 3 were removed for cause. Other separations, principally of agents, unskilled laborers, and seasonal temporary employees numbered 292, making the total separations for the fiscal year 555. On June 30, 1931, the bureau rolls carried 4,570 employees.

LITERATURE, EXHIBITS, AND MOTION PICTURES

Publications prepared by the bureau included 92 new and revised documents, which augmented materially the available literature on subjects pertaining to livestock and their products. Contributions to the various series of publications included 26 farmers' bulletins, 9 technical bulletins, 4 circulars, 1 department leaflet, 6 contributions to the Journal of Agricultural Research, 6 orders of regulatory character, 24 Yearbook articles, 13 Service and Regulatory Announcements including an index, the bureau directory, and 2 publications of miscellaneous character. In addition, employees of the bureau contributed 131 manuscripts on various phases of livestock work and research to technical and agricultural periodicals published outside of the department. As in the past, there were furnished to the press service of the department numerous timely articles dealing with the results of research work, the announcements and interpretation of regulations, and other topics of public interest.

Officials of the bureau also participated frequently in radio broadcasts besides contributing and reviewing a large volume of material intended for department radio programs.

In cooperation with the department's office of exhibits, specialists of the bureau furnished subject matter for the preparation of 7 new exhibits and the revision of 11 former ones for use at State, inter-

state, and international fairs and expositions. In addition exhibit material was prepared for 19 other events.

The work of the various divisions of the bureau is presented more fully in the following pages.

ANIMAL HUSBANDRY DIVISION

The work of the Animal Husbandry Division, consisting chiefly of research in animal husbandry, including poultry husbandry, was conducted under the direction of E. W. Sheets, chief.

ANIMAL GENETICS

Analysis of data in the bureau's inbreeding investigations with guinea pigs shows that the five surviving lines have differed significantly from one another in all measures of fertility, mortality, and growth from the beginning of the experiment 25 years ago. The data show also that the lines have reacted differently to inbreeding or to conditions of environment during the 25-year period, so that the rankings of the different families in these measures of vigor have changed at various times during this period. There has been a decline in all measures of vigor, but decline in fertility has been the greatest, and in growth the least. Both prenatal and postnatal mortality has increased in all lines during the 25 years.

The families differ in average length of life, both males and females of one family living longer, on the average, than even the control stock. In two of the families and the control stock the birth weight of young raised has increased, as has also the weaning weight in the control stock. General conditions rather than inbreeding are apparently responsible for much of the decline in the inbred stock, for the control stock has suffered almost a parallel decline, though at a higher level.

Swine-inbreeding investigations have progressed to the point where one inbred line of the Chester White and one of the Tamworth breeds have advanced to the fourth generation in sufficient numbers to give reasonable assurance that fourth-generation breeding stock will be raised to sexual maturity.

In the fall of 1930 and the spring of 1931 there were farrowed 14 first-generation, 31 second-generation, 32 third-generation, 25 fourth-generation, 41 crossbred, and 19 back-cross pigs.

The year's work has shown that: (1) Inbred strains can be established which will make as rapid and economical gains as noninbreds; (2) type may be amenable to genetic control; (3) crossbreds are not always superior in vigor and gains to purebreds; and (4) fertility and low mortality are probably more important in economical swine production than the minor differences in type and rate of gain which were segregated by inbreeding. Thus far no indication of inherited factors for high fertility has appeared, the data showing that fertility declines when inbreeding is practiced.

ANIMAL NUTRITION

A study of the composition of carcasses of lambs of different grades and of the separable fat and lean of the various wholesale cuts from these carcasses showed a progressively increasing amount of fat in

many of the cuts as the carcasses became higher in grade. This observation agrees with the trade practice in determining grade, as far as it applies to fatness.

Swine fed rations containing moderate amounts of cottonseed oil produced a harder fat than animals fed on corresponding amounts of oils such as peanut or soybean oil. The cause for this greater hardness seems to be in the nature of the fatty acid contained in cottonseed oil.

In a study of the causes of soft condition of hog carcasses, investigations were conducted in which swine were fed at different nutritive levels, full feed and less. The purpose was to determine the effect of retarded growth, when animals received softening feeds, upon subsequent gains made with hardening feeds. The results of this study have yielded important information on the efficiency of swine in utilizing varying amounts of feed. Swine fed at less than full-feed levels in these investigations were more efficient in the ultimate utilization of their feed than were those that were full fed. The former used much less feed per 100 pounds' gain but required somewhat longer feeding periods to reach the same weights. Similar results were obtained with corn-and-tankage rations. These results indicate that where the labor cost and market situation are favorable, or where a predominance of leaner cuts is desired, limited feeding of swine, even under dry-lot conditions, may be a practical and efficient method for further reducing swine-production costs. On the other hand, full feeding is necessary when rapid finishing is desired for early marketing or when a large quantity of lard is desired.

Lightweight barley was found to be equal, if not superior, to heavy barley in feeding value on an equal-weight basis in tests with rats, when the barley furnished the only source of protein in the rations. The light barley contained a higher percentage of protein than did the heavy barley.

COOPERATIVE EXTENSION

During the year, the Animal Husbandry Division continued to cooperate, through two extension representatives, with the office of cooperative extension work and State extension workers in the establishment and continuance of projects aimed toward livestock improvement.

In spite of unfavorable and unusual situations precipitated by the worst drought in a generation and the world-wide business depression, the entire extension program made satisfactory progress during the year.

Efforts to improve quality and economy in production practices were outstanding objectives in projects carried on in all sections of the country. The value of purebred sires, especially those of known breeding ability, was stressed in connection with the production of all species of livestock. The tendency to base the work on complete cycles of production rather than on single practices in order to fit more completely into practical systems of farming was more marked during the year than previously.

The development of pork-production clubs, an outgrowth of ton-litter work, is an example of this type of activity. This project requires the application of all known principles of improved swine production to all the brood sows and their offspring on an indi-

vidual farm. In the former single-litter type of project, it was unusual for the farmers of any State to produce as many as 75 ton litters in a single year, whereas with the new type of work nine farmers in one State last year produced 99 litters which averaged more than a ton.

In poultry-extension work emphasis has been placed on sanitation. Disease-eradication programs, popularly called "Grow Healthy Chicks" campaigns, have been intensively carried out and are resulting in an increased efficiency in raising young stock. The efficient culling of the low-producing hen has been demonstrated by extension workers and is being practiced by flock owners much more generally than in previous years.

MEAT INVESTIGATIONS

Meat investigations have been continued in cooperation with the Bureaus of Agricultural Economics and Home Economics and 22 State experiment stations. The results from the various lines of study show interesting trends and suggest the nature of the final conclusions. Rate of gain, for example, was found to be an important factor in the development of desirable eating qualities of meat, retarded growth lowering the palatability. Effort is being made to determine the exact "danger line," or the effect of a temporary shortage of feed or a prolonged shipping shrink on the palatability of the meat.

Breed comparisons thus far have failed to show marked differences in the palatability of the cooked meat. However, striking variations have been found in both the composition and palatability of the meat from individual animals within the same breed. From these results it appears that future breed studies should deal more largely with efforts to identify and further improve superior families or strains of meat animals within the breed.

In beef-carass-grading studies it was found that the grade of the carcass was closely related to the thickness of external fat or the degree of finish. In view of the cost of adding finish to market animals and the consumers' dislike for excess fat, it is of great economic importance to determine the minimum degree of finish that will produce the necessary yield, attractiveness, storage quality, and consumer value in slaughter animals.

Well-bred beef calves which had been fed all the supplementary grain they would eat up to weaning time, while running with their dams on pasture, graded higher as feeder calves at weaning time than did similar calves fed little or no supplemental grain while on pasture. The grain-fed calves also showed a comparable superiority in grade as slaughter cattle and carcasses after a 196-day fattening period in dry lot.

Results of a comparative study of Wiltshire sides of American, Danish, Irish, Polish, and Swedish origin suggest that the foreign discrimination against American Wiltshires may be due, at least in part, to overcuring our product. The more mildly cured foreign sides arrived in this country in as sound condition as the heavily cured sides. It appears that heavy curing probably is not essential to insure the American products reaching the foreign market without deterioration.

Results of six experiments comparing the influence of fish meal and tankage in hog rations on the desirable flavor and aroma of the roasted meat showed no marked differences. Four of these experiments were conducted in cooperation with the New Jersey Agricultural Experiment Station, and two by the department alone. Menhaden fish meal was used in all cases. The highest proportion of fish meal in the ration in any case was 10.4 per cent, fed from soon after the time the pigs were weaned until they weighed approximately 100 pounds, after which 7.5 per cent of fish meal was fed until the pigs reached a finished weight of approximately 225 pounds.

In six experiments a comparison of corn and peanuts, as basal feeds in fattening rations for hogs, showed no distinct differences in desirable flavor and aroma of the roasted fresh pork. One of these experiments was conducted in cooperation with the North Carolina Agricultural Experiment Station, one with the Virginia station, and the others by the department alone.

Lamb studies during the year involved comparisons of feeds, rations, management, castration, breeding, degree of finish, and rate of growth. Phases of the lamb work completed during this time included studies of the influence of ram and wether characteristics on the production and quality of their meat, studies of the influence of the breed of the sire on the production and quality of lamb meat, and the effects of aging legs of lamb in cold storage on the palatability of the meat.

During the year carcasses or parts of carcasses of 228 cattle, 706 hogs, and 810 lambs were studied at the division's meat laboratories.

RECORD-OF-PERFORMANCE STUDIES

Performance studies were continued with swine, and similar studies were begun with cattle and sheep. Consideration is being given to production efficiency, including both breeding and feeding performance, as well as carcass yield and quality of the meat produced.

Data were obtained on 14 litters of pigs. Test groups of 4 pigs from each of the litters, all self-fed on the same feeds, made average daily gains ranging from 0.83 to 1.47 pounds. The feed consumed per 100 pounds gain for the 14 groups ranged from 461.2 to 356.6 pounds.

Two barrows and one sow were slaughtered from each of the test groups, and detailed carcass observations were made. Cutting yields of these carcasses, based on final feed-lot weights of approximately 225 pounds varied: In percentage of ham, from 13 to 15.3; in bacon, from 8.1 to 11.6 per cent; in shoulder, from 6.4 to 8.1 per cent; and in loin, from 8.9 to 11.8 per cent.

The variability of these results indicates the opportunity for swine improvement through selection and breeding. The studies now in progress are designed to discover and improve the most efficient families and strains of each class of animals.

BEEF AND DUAL-PURPOSE CATTLE INVESTIGATIONS

Research in beef production was conducted during the year at 24 Federal and State experiment stations.

BEEF-CATTLE RESEARCH IN EASTERN UNITED STATES

The second year's work of a 3-year experiment to compare grass alone and grass supplemented with corn and cottonseed meal for fattening 2-year-old steers, was completed at Lewisburg, W. Va., in cooperation with the West Virginia Agricultural Experiment Station.

Steers that were grazed 140 days and fed a grain supplement for the last 84 days were more profitable than similar steers on grass alone for 140 days or steers receiving a grain supplement throughout the entire grazing period of 140 days. These results agree with those of the previous year's work. Steers on grass for 196 days and fed grain for the last 56 days were not so profitable as steers removed from pasture and fed grain in dry lot for 56 days. Gains in the dry lot were greater for each of the two years. These results indicate that feeding in a dry lot is to be preferred to fattening steers by feeding grain on grass late in the fall.

In a similar test at Blacksburg, Va., in cooperation with the Virginia Agricultural Experiment Station, steers on grass and grain for 140 days made average gains of 306 pounds per head, as compared with 290 pounds for steers fed grain the last 84 days of the period, and with 230 pounds of gain for steers on grass alone. Heifers fed grain the last 56 days gained 44 pounds less than did steers handled in the same way.

At the United States Animal Husbandry Experiment Farm, Beltsville, Md., a grazing experiment has been carried on for the second year in cooperation with the Bureau of Plant Industry to determine the rate of stocking and the system of management which will produce maximum gains per acre on improved pasture of mixed seeding. The results thus far indicate that 2 acres of pasture of this character provide adequate continuous grazing for a yearling steer even under the abnormally dry conditions experienced during the time. One acre of such pasture was not sufficient to keep a yearling steer gaining satisfactorily, and the results from rotated grazing at the same rate of stocking were only slightly more satisfactory.

Six pairs of yearling steers were used in an experiment to determine the suitability of coarsely ground, lightweight, scab-infested barley supplemented with alfalfa hay for steer fattening and the comparative value of such barley with normal barley and alfalfa hay. One member of each pair of steers was fed all the scab-infested barley and alfalfa hay it would readily eat, whereas the other was fed an equal quantity of normal grain and alfalfa hay, daily feed consumption averaging 10.6 pounds of barley and 5.7 pounds of alfalfa hay for 210 days. The results of this experiment showed that when fed with alfalfa hay, lightweight, scab-infested barley is practically as satisfactory as normal-weight, noninfested barley in a limited grain ration. The steers fed the scabby barley gained an average of 1.32 pounds per head daily as compared with 1.38 pounds by those receiving the normal barley.

In a 140-day winter feeding period steers fattened on a ration of cracked wheat fed in a self-feeder and alfalfa hay made almost as economical gains as steers hand-fed the same ration. The self-fed

steers gained an average of 2.2 pounds per head daily, as compared with 2.1 for the hand-fed steers, but they consumed a slightly greater quantity of feed. The fact that the steers of both groups gained well and produced beef grading prime and choice indicates that wheat is a very satisfactory fattening feed for beef cattle.

BEEF-CATTLE RESEARCH IN THE MIDDLE WESTERN STATES

An experiment to determine the value of corn alone, corn and cottonseed cake, and corn and oats as supplemental grain rations for spring calves to be marketed fat at an early age was completed at Sni-A-Bar farms, Grain Valley, Mo., in cooperation with the University of Missouri.

Three lots of high-grade Shorthorn steer calves averaging 79 days of age were creep-fed these grain rations while running with their dams on pasture. The calves fed 298 pounds of shelled corn on pasture before weaning showed a lower cost of gains and made greater returns than those receiving 453 pounds of corn and 57 pounds of cottonseed cake, and those fed 446 pounds of corn and 223 pounds of oats.

BEEF-CATTLE RESEARCH IN THE SOUTH

At the Coastal Plain Experiment Station, McNeill, Miss., in cooperation with the Mississippi Experiment Station, in a total of eight years' experiments, burned-over pasture land has produced one-third greater cattle gains than unburned pasture without apparent injury to longleaf pine saplings already established.

In a comparison of steer calves of one-half Brahman blood with similar calves of one-fourth Brahman blood, at the Iberia Livestock Experiment Farm, Jeanerette, La., in cooperation with the Louisiana Experiment Station, no significant difference appeared in the rate of gain.

To compare the effect of varying proportions of corn and molasses on the rate of gain and financial returns from yearling steers, a 112-day feed-lot experiment with three lots of 600-pound steers was carried on at Moultrie, Ga., in cooperation with the Georgia Agricultural Experiment Station. Shelled corn and molasses were fed in the ration with cottonseed meal and cottonseed hulls. With an increase in the quantities of molasses substituted for corn, the gains and financial returns became smaller.

BEEF-CATTLE RESEARCH IN THE SOUTHWESTERN STATES

An experiment was conducted at Beeville, Tex., in cooperation with the Bureau of Plant Industry and the Texas Agricultural Experiment Station, to compare (1) hegari with corn and (2) hegari stover with sumac fodder, for fattening calves. Hegari is a comparatively new grain sorghum. Cottonseed meal was included in both rations. A lower cost of gain and slightly more favorable net return were obtained with the rations containing hegari despite a selling price of 40 cents a hundred less for the calves fed those rations.

At the United States Dry Land Experiment Station, Big Spring, Tex., in cooperation with the Texas Agricultural Experiment Station, 30 yearling steers were fed 140 days to determine the relative

efficiencies, for producing weight and finish, of sumac fodder, sumac fodder with alfalfa hay, and cottonseed hulls with alfalfa hay, when fed with ground milo heads and cottonseed meal. Although the past year's results were somewhat inconclusive, owing to the use of immature sumac fodder, the ration of sumac fodder with ground milo heads and cottonseed meal was the most efficient in economy of gain and finish of the carcasses.

BEEF-CATTLE RESEARCH IN WESTERN RANGE AREAS

At the United States Range Livestock Experiment Station, Miles City, Mont., in cooperation with the Montana Experiment Station, cows fed 131.5 pounds of cottonseed cake per head, during a period of 150 days, on winter range produced 349.4 pounds of calf per cow at weaning time, whereas cows receiving no supplemental feed while on winter range produced only 323.3 pounds of calf per cow.

In a plane-of-nutrition experiment, covering 104 days of winter feeding and 224 days of summer range, to study the effects of feeding low, medium, and high levels of feed, the medium-plane steer calves gained 371.9 pounds and were most profitable, although the steers on the high feed level gained 388.7 pounds but at an increased feed cost. The low-plane steers gained 342.9 pounds. The medium-plane steers received a daily ration of 9.9 pounds of alfalfa hay and 2.1 pounds of oat straw per head during the winter-feeding period.

In a similar test involving 74 days of winter range, 71 days of winter lot feeding, and 226 days of summer grazing, low-plane yearling steers receiving a daily ration of 5.6 pounds of alfalfa hay and 13.78 pounds of oat straw were more profitable than similar steers maintained on medium and high feed levels. The low-plane steers gained, on an average, 363.6 pounds, the medium-plane steers 367 pounds, and the high-plane steers 400.5 pounds.

Heifer calves that were winter-fed 11.9 pounds of alfalfa hay and 1.6 pounds of oat straw per head daily made practically the same total winter and summer gains as did similar calves fed equivalent quantities of bluejoint hay and oat straw. Similar results were obtained with yearling heifers. Yearling heifers full-fed alfalfa hay with oat straw for a winter feeding period of 57 days made greater total winter and summer gains than did similar heifers receiving only half as much of the same ration per head daily but for 90 days.

At the Ardmore Field Station, Ardmore, S. Dak., experiments carried on in cooperation with the Bureau of Plant Industry in wintering yearling steers, showed that 13 pounds of sorgo fodder was equal in feeding value to 8 pounds of alfalfa hay and 4 pounds of oat straw. These rations produced a winter gain of more than 50 pounds a head, whereas a daily ration of 16 pounds of corn silage and 4 pounds of oat straw produced a winter gain of less than 5 pounds a head.

In a grazing experiment, with steers, which has been carried on for 14 years, rotation grazing increased the carrying capacity of native pasture about 5 per cent over that of continuously grazed pasture. The rotated pasture produced 20 pounds of steer gain per acre annually, the continuously heavily grazed pasture produced 19 pounds, and the continuously lightly grazed pasture produced 14 pounds. The average total gains of steers were greater under

rotated grazing than under heavy grazing but less than under light grazing. When only lightly grazed, the pasturage tended to become coarse and unpalatable.

At the North Montana branch station, Havre, Mont., in cooperation with the Montana Agricultural Experiment Station, average results of four years' experiments in wintering breeding cows show that 16.7 pounds of oat hay per head daily produced a winter gain of 80.3 pounds per head, whereas 22.6 pounds of corn fodder produced a gain of but 53.4 pounds a head.

In a comparison of a full feeding of alfalfa hay and oat straw with a limited feeding of the same ration for wintering breeding heifers, an average winter gain of 78.2 was obtained on the full feed as compared with 59.3 pounds on the limited ration.

Range studies in North Park, Colo., and in Saratoga Valley, Wyo., in cooperation with the Bureau of Agricultural Economics and the State experiment stations, are again indicating that better calf crops are obtained from pasture breeding than from breeding on the open range or forest reserve. Based on the number of calves alive at weaning time, the difference in favor of the pasture was 7 per cent in 1930 and 11 per cent in 1929. The results thus far analyzed for the fiscal year 1931 indicate that the death loss of calves from birth to weaning was 5.74 per cent for the pasture group and 7.38 for the other groups.

DUAL-PURPOSE CATTLE RESEARCH

The project to determine the mode of inheritance of milking and beef characteristics in dual-purpose cattle and the possibilities of fixing these dual qualities in high degree so that they may be transmitted with uniformity and regularity was continued at Beltsville, Md., and Middlebury, Vt.

A cooperative project was worked out during the year with the North Dakota Agricultural College, and a foundation herd was established at Edgeley, N. Dak. A herd of 20 Shorthorn heifers headed by a proved sire was established at the Andrew Drumm Institute, Independence, Mo., in cooperation with the University of Missouri.

SHEEP, GOAT, AND ANIMAL-FIBER INVESTIGATIONS

Research in problems of the sheep, goat, and animal-fiber industries included experimental work at 17 Federal and State experiment stations, 1 wool-scouring plant, 2 woolen mills, 1 mohair mill, and 1 hospital clinic for testing the food value of goats' milk for infant feeding.

FARM-SHEEP INVESTIGATIONS

Studies of the sheep-carrying capacity of various forage-crop pastures at Beltsville, Md., during the year emphasized the importance of adequate rainfall.

A decrease of more than one-half in the carrying capacity of soybean and corn-and-velvet-bean pastures was the result of the severe drought of the summer of 1930. On the other hand, a material increase in the grazing yields of the oats and peas, wheat, barley, and rye pastures is attributed to favorable rainfall in the spring of that year.

Experiments to determine the value of flushing (the practice of giving ewes extra feed at breeding time to increase the lamb crop) were continued at Beltsville, Md. The results again emphasized the value of good pasture for this purpose. Ewes flushed on extra good pasture produced 164 lambs per 100 ewes, whereas those flushed on grain produced 152 lambs per 100 ewes. The control lot of unflushed ewes, not receiving any extra feed at breeding time, produced only 143 lambs per 100 ewes.

At Middlebury, Vt., ewes flushed on a daily ration of good-quality legume and mixed hay, 2 pounds of corn silage, and 1 pound of grain per ewe produced 13 lambs per 100 ewes more than unflushed ewes fed poor-quality, nonlegume hay and 2 pounds of corn silage per ewe daily.

The grading-up experiment at Middlebury, Vt., again showed third-cross Shropshire and Southdown lambs to be more profitable, by \$1.68 a head, than those of higher grades, although they were not so typical in conformation and breed character as the fourth and fifth-cross lambs. The results of this year's work, as well as that of previous years, showed that the market (Jersey City) to which the lambs were sent was more interested in the better finish and handier size of the third-cross lambs than in the improved conformation and breed characters of the fourth and fifth cross lambs.

Results of an experiment to compare rams with wethers from the standpoint of market desirability were in agreement with results of similar previous tests. As appraised on the Jersey City market, wether lambs raised at Middlebury, Vt., were worth 37.5 cents per 100 pounds more than the ram lambs. In the bureau's laboratories at Beltsville, Md., the wethers also yielded slightly higher dressing percentages and a larger proportion of edible meat in the cuts tested. However, owing to their greater weight, the ram lambs were worth 49 cents more per head on the basis of the Jersey City appraisal than were the wether lambs.

At the Belle Fourche Field Station, Newell, S. Dak., in cooperation with the Bureau of Plant Industry and the South Dakota Experiment Station, it was found to be more profitable, and without any harmful effect on the ewes themselves, to breed ewe lambs at ages of 7 to 9 months than to delay breeding until they are from 17 to 19 months of age, provided the earlier bred ewes were given good feed and care. Of a lot of 24 high-grade Hampshire ewes, 7 to 9 months old, 12 averaging 89.1 pounds in weight, were bred in September, 1928, and the remainder, averaging 90.8 pounds, were carried over until September, 1929, before breeding. At this time the ewes that had been bred as lambs averaged 130.7 pounds, and the ewes being bred for the first time averaged 148.7 pounds. When the ewes were 2 years old, there was about 5 pounds difference in the average weights of the two groups, the ewes bred as lambs averaging 141.8 pounds and the others 146.9 pounds.

RANGE-SHEEP INVESTIGATIONS

At the United States Sheep Experiment Station, Dubois, Idaho, studies begun in 1924 in cooperation with the Forest Service are showing the effect of various methods of range management on the

carrying capacity of the range. The results are aiding range sheepmen in the most profitable management of grazing land. One striking comparison can be seen in miniature in two experimental pastures, of 80 acres each, adjacent to each other near station headquarters. One of these pastures has been ungrazed in the spring but grazed fully in the fall, whereas the other, since 1924, has had early and continuous spring grazing in addition to full grazing again in the fall. The pasture grazed only in the fall now has a relatively dense cover of vigorous forage containing a declining stand of sagebrush, whereas the pasture grazed both in the spring and fall has decreased in carrying capacity year by year until at present it furnishes only about one-third as much feed from a very sparse cover of forage and contains mostly vigorous sagebrush.

Experiments on the breeding of range Rambouillet and Corriedale ewes to Southdown rams for the production of market lambs are in progress. Results thus far have been favorable to the production of Southdown-sired lambs on ranges of good lush forage. They have developed into excellent fat lambs.

Results of flushing experiments with range sheep are in general accord with those already reported for farm flocks. At the United States Range Livestock Experiment Station, Miles City, Mont., 623 Rambouillet ewes flushed at breeding time by feeding one-half pound of cottonseed cake per head daily throughout the breeding season produced 120.9 lambs per 100 ewes, whereas the 612 ewes of the band which were not flushed yielded only 109.5 lambs per 100 ewes. The flushed ewes produced an average of 66.2 pounds of live lamb per ewe at weaning time as compared with 62.8 pounds by the unflushed ewes, an increase of 3.4 pounds of live lamb for the 21.83 pounds of cottonseed cake consumed per ewe.

A group of 611 Rambouillet ewes fed an average of 0.5 pound of cottonseed cake per ewe daily on the range through the winter feeding period produced 2.2 pounds of live lamb per ewe more than 624 ewes receiving no supplemental feed.

The Rambouillet ewes that gained in weight during the breeding season produced on an average 10 more lambs per 100 ewes than those which failed to gain. Those gaining in the winter after the breeding season produced 67.3 pounds of live lamb per ewe by weaning time as compared with 63.6 pounds for those not gaining during this time.

KARAKUL-SHEEP INVESTIGATIONS

Investigations in the production of skins valuable for fur were continued at Beltsville by crossing Corriedale, Blackfaced Highland, and Hampshire ewes with Karakul rams and comparing the skins of the lambs thus produced with those of purebred Karakul lambs with respect to tightness of curl and luster of the fur. The skins of the purebred Karakul lambs averaged best in tightness of curl, but those of the second-cross Karakul-Blackfaced Highland lambs were almost as good. In luster of fiber the skins of these second-cross Karakul-Blackfaced Highland lambs were the equal of the purebred Karakul skins, these lines of breeding surpassing the others in this respect. The skins of the first-cross Karakul-Blackfaced Highland lambs were superior in both respects to those of the second cross Karakul-Corriedale lambs, whereas the first-cross Karakul-

Hampshire lambskins were the poorest of any lot. These experimental lambskins are being used in further studies of their fur value through cooperation with the Bureaus of Biological Survey and Home Economics.

ANGORA-GOAT AND MILK-GOAT INVESTIGATIONS

Studies in the improvement of mohair through breeding and selection were continued with Angora goats, in cooperation with the Texas Agricultural Experiment Station. The fleeces are being carefully studied at mohair mills. Results thus far obtained encourage the belief that definite improvement is being made.

Studies of milk production of Toggenburg and Saanen goats emphasized the value of good pasture for this purpose. Does kept on fall-sown rye pasture for 16 days in the spring and fed a grain mixture of 8 parts corn, 4 parts oats, 2 parts bran, and 1 part linseed meal at the rate of 1.5 pounds per head daily produced 12 per cent more milk than in the preceding 16-day period in which the pasture had been replaced by 1 pound of corn silage and 3 pounds of good-quality alfalfa hay per head daily. On this same ration in the 16-day period immediately following the period the goats were on pasture, their milk production fell 7.5 per cent.

STUDIES OF WOOL AND OTHER ANIMAL FIBERS

An analysis of the weights of more than 2,000 fleeces produced at the United States Sheep Experiment Station, Dubois, Idaho, from 1925 to 1927 showed that, of three breeds studied, Columbia sheep produced the greatest weights of wool, averaging 4.24 pounds of clean wool per fleece as compared with 3.78 pounds for Rambouillets and 3.60 pounds for Corriedales.

In a study of fleeces at the same station it was found possible to predict, with a fair degree of accuracy, the grease content of fleeces produced by individual sheep in succeeding years when the grease content of their fleeces as yearlings was known. Thus it appears that the grease content of the wool of yearling sheep is maintained with but slight variation in succeeding fleeces sheared from the same sheep provided they are produced under similar conditions of feed and climate.

In a comparison of shrimp bran and linseed meal to determine the effect of these feeds on wool production, no material difference was found. The fleeces from the ewes fed shrimp bran yielded 52.7 per cent of clean wool, as compared with 52.3 per cent from the fleeces of the ewes fed the linseed meal.

Studies of the possibility of determining the yield of clean wool of fleeces, by compressing unscoured wool of known weight in a metal cylinder under definite pressure to obtain the volume per unit of weight, indicate that this can be done with reasonable accuracy. The method is more nearly accurate than the usual yield estimates of expert judges.

The testing of hair for pillows, mattresses, upholstery, and brushes was continued in connection with the work of the Federal Specification Board for Government purchases. These tests have resulted in obtaining products, for governmental use, which complied

in every detail with specifications, and also in considerable saving in the purchase of supplies.

GOAT-MILK INVESTIGATIONS

Comparisons of goat milk with the milk of Holstein and Jersey cows were continued. As in the preceding year, the milk was produced under controlled conditions and fed to infants under the direction of Johns Hopkins University, Baltimore, Md.

In nutritive properties, including vitamin content, no one milk showed marked superiority over the other two. Jersey milk was found to contain somewhat more vitamin A and goat milk contained more of vitamins B and C. The vitamin C content of all three milks, produced in both summer and winter, was found to be low. The vitamin D content of all three milks was approximately the same. In general the vitamin content of milk produced in summer was found to be higher than that produced in winter.

Goat milk and Holstein milk were found to be somewhat similar in content of protein, fat, and total nutrients and Jersey milk was higher than either in these constituents.

MILK SUBSTITUTES AND SUPPLEMENTS

An experiment to develop formulas of milk substitutes and supplements for feeding newborn farm animals was begun during the year. The purpose was to find means of reducing heavy losses resulting from orphaning, or insufficiency or unsuitability of the milk of the dam.

Data on the influence of the ingestion of colostrum on the protein content of the blood of the newborn lamb, foal, kid, calf, and pig were offered for publication. Other phases of the experiment are being continued.

SWINE INVESTIGATIONS

Investigations in various phases of swine production were continued during the past year at Beltsville, Md., and at the several field stations.

At Beltsville, Md., three lots of pigs averaging 65 pounds in weight were fed a ration, known to cause softness in pork, until an average gain of 40 pounds was obtained. The lots were then fed a pork-hardening ration containing different proportions of cottonseed meal, on which the pigs were finished at average weights of approximately 225 pounds. In addition to cottonseed meal, the hardening ration contained corn, tankage, alfalfa-leaf meal, salt, bone meal, and ground limestone.

A hardening ration containing 13 per cent of cottonseed meal produced average daily gains of 1.8 pounds; the lot receiving this ration was the most economical in feed consumption of all groups. A second group fed a hardening ration containing 19 per cent of cottonseed meal was poorest in feed economy. Although the third lot, fed a hardening ration containing 25 per cent of cottonseed meal, made average daily gains of 1.6 pounds, these gains were only slightly more economical than those made by the lot receiving the 19 per cent cottonseed-meal ration.

In order to measure actual feed consumption per pig per unit of gain on the same rations, three lots of three pigs each were individually fed. This test further emphasized the economy of the hardening ration containing 13 per cent cottonseed meal. Feed consumption per 100 pounds of gain on this ration was only 414 pounds, with an average daily gain of 1.6 pounds per pig, whereas for the ration containing 19 per cent cottonseed meal it was 425 pounds, with an average daily gain of 1.5. For the ration containing 25 per cent of cottonseed meal feed consumption was 484 pounds per 100 pounds of gain with an average daily gain of only 1.4 pounds per pig.

A study of the economy of gain in hogs fed 2, 3, and 4 per cent rations from average initial weights of 65 pounds to finished weights of 200 pounds indicated that the lower levels of feeding are more economical in the production of pork. Price fluctuations and time of marketing, however, may offset this advantage.

In comparative tests of light, medium, and heavy barley, for growth and development of pigs, the light barley, pound for pound, showed greater efficiency than the heavy barley.

One year's work was completed on a comparison of damaged wheat and normal wheat as a grain feed for hogs. Results showed that 409 pounds of damaged wheat were required to produce 100 pounds of gain as compared with 365 pounds of normal wheat. The importance of accurately determining the value of damaged wheat in the feeding of livestock makes it desirable to conduct further work with hogs and to make similar feeding tests with other classes of livestock.

In a feeding experiment of 126 days' duration to determine the relative value of old sows and gilts for breeding animals, pigs from old sows made average daily gains of 1.44 pounds; those from gilts whose dams were old sows, 1.35 pounds; and those from gilts whose dams were gilts, 1.42 pounds. The total feed requirements per 100 pounds of gain were 415, 406, and 394 pounds, respectively.

HORSE INVESTIGATIONS

Horse investigations were conducted at the United States Morgan Horse Farm, Middlebury, Vt., the United States Range Livestock Experiment Station, Miles City, Mont., and the United States Animal Husbandry Experiment Farm, Beltsville, Md.

Cooperative contacts were maintained with the War Department in continuing investigational and remount breeding work. Studies in cooperation with the Storrs Agricultural Experiment Station, Storrs, Conn., in determining hay requirements of city work horses have been completed, and a report of this work has been prepared for publication.

Accumulated data on the farm power studies conducted in cooperation with the Bureau of Agricultural Economics, the Bureau of Public Roads, and 11 States are now being analyzed and prepared for publication by the cooperating bureaus.

UNITED STATES MORGAN HORSE FARM

The principal lines of investigation being carried on at the United States Morgan Horse Farm during the year included: Factors relating to the breeding, feeding, and management of light horses; vertebrae

studies; and the correlation between period of pregnancy and season of foaling. The work at this farm was conducted as heretofore with a stud of purebred Morgan horses, which during the year numbered 86 animals. Interest in these horses has continued and there was a good demand for surplus stock. The foals produced during the year were very uniform in type, weight, and height, the range in birth weights being from 92 to 127 pounds and the variation in height from 36 to 39 inches. Public interest in the work of this station was indicated in an attendance, at the annual Morgan Horse Club field day, held in May, of approximately 400 people.

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

Work on the production and management of purebred and grade draft and light horses under range conditions was continued at this station with a stud of 241 animals.

In feeding trials of 168 days to compare the feeding value of alfalfa and native hay, weanling colts of the light-horse type made an average daily gain of 1.6 pounds on an average daily ration of 5 pounds of grain and 12.8 pounds of alfalfa hay, whereas a second lot of colts made an average daily gain of only 1.2 pounds on a daily ration of 5 pounds of grain and 9.5 pounds of native hay. The grain ration consisted of 3 parts of ground oats and 1 of bran. The average total gain of alfalfa-fed colts was 273.2 pounds per head, whereas the average total gain of the colts fed native hay was only 197.3 pounds per head.

Weanling draft colts fed a daily ration of 8 pounds of whole oats and 15.8 pounds of alfalfa hay per head for 168 days made an average daily gain of 2.1 pounds and a total gain of 350.1 pounds per head. These results emphasize again the value of good-quality alfalfa hay for the raising of colts.

UNITED STATES ANIMAL HUSBANDRY EXPERIMENT FARM

The horses maintained at this farm are used both for investigational purposes and station work. Two purebred Morgan mares produced filly foals from a mating with a Thoroughbred stallion in a study to determine the value of this cross in producing horses for saddle purposes.

CERTIFICATION OF ANIMALS IMPORTED FOR BREEDING PURPOSES

Under the provisions of paragraph 1606 of the tariff act of 1930 the bureau issued certificates of pure breeding for 355 horses, 4,764 cattle, 1,419 sheep, 22 swine, 1,246 dogs, and 12 cats. The total number of animals, of all breeds, certified during the fiscal year was 7,818.

POULTRY INVESTIGATIONS

POULTRY BREEDING

Major projects in poultry breeding continued during the year included studies of the inheritance of egg production, the effect of inbreeding on various characters, the inheritance of body weight, physiological factors affecting hatchability, and the inheritance of

a number of characters such as shape and color of egg, barring in sex-linked crosses, and the factors for gold and silver in Partridge and Silver-Penciled Plymouth Rocks.

Flocks of 378 White Leghorn pullets and 319 Single-Comb Rhode Island Red pullets at the United States Animal Husbandry Farm, Beltsville, Md., completed their first year with average egg productions of 185 and 187 eggs, respectively. These averages compare favorably with records of the previous year.

The percentage of fertile eggs produced by White Leghorns was 91.5 and by Rhode Island Reds, 87.6.

In the White Leghorns the percentage of hatchability of fertile eggs set was 72.8; and in the Rhode Island Reds, 77.5. Hatchability results were superior to those of previous years, partly because the breeding stock had been selected on the basis of hatchability. The study on hatchability brings out the fact that hatchability is inherited, although there are physiological factors that affect the results obtained from any particular mating. The available evidence suggests that possibly more than one gene or factor is involved in this inheritance. Inbreeding tends to decrease hatchability, whereas outbreeding tends to increase it.

A study of the effect of current egg production on hatchability has shown that, contrary to general opinion, high egg production during the breeding season is apparently conducive rather than detrimental to good hatchability.

Studies on sex ratio in the domestic fowl indicate that the proportion of males is slightly less than half, and that size of family has little influence on the sex ratio. Further observations suggest that inbreeding in the domestic fowl can hardly be regarded as a sex-influencing factor even when close inbreeding is practiced.

A lethal character "stickiness," which prevents the hatching of certain chicks, has been discovered and has been found to be inherited. In a study of associated physiological characters, it was found that calcium metabolism was very faulty, causing soft bones.

POULTRY FEEDING

Hens on diets containing protein from vegetable sources only or protein supplements which are by-products of the oil and fat industries produced eggs of inferior hatchability. In such eggs the mortality of embryos during the second week of incubation was high.

Eggs from hens on diets deficient in vitamin B were found to hatch, but the chicks hatched from them usually died of polyneuritis within 48 hours after hatching.

Eggs were treated with X rays to test the claims that sex could thus be controlled. Exposures reported to have been effective were found to be fatal. Treatment of eggs by X rays is unlikely to prove a means by which the sex of the resulting chicks can be controlled.

A year's study of the relation between level of food consumption and growth has been completed. The results thus far obtained seem to indicate that it is not economical to keep feed before growing chicks all the time. However, a market restriction of the feed supply tends to increase mortality, and the surviving chicks are not of a quality to command a satisfactory market price.

A continuation of the study of the relative value of ultra-violet irradiation and cod-liver oil for laying hens confined indoors yielded results substantially in agreement with those previously obtained. With the diets used, cod-liver oil was found to be superior to ultra-violet irradiation for egg production.

The study of growth and fattening rations has been continued. This work has shown that it is possible to rear strong, healthy chicks in confinement on a diet containing only yellow corn meal and dried buttermilk, provided a sufficient amount of vitamin D is supplied.

A 2-year experiment on the feeding of scabby barley has shown that it gives as good results as sound barley when fed in a laying mash to pullets and hens.

A study of a deforming leg weakness in young chickens has shown that this condition may be prevented among chicks raised in confinement by adding from 6 to 10 per cent of rice bran to their ration, at the same time adjusting the ratio of calcium to phosphorus in the diet to approximately 2.5 to 1.

Feeding experiments at the United States Poultry Experiment Station, Glendale, Ariz., have shown that although freshly cut green alfalfa is an excellent source of vitamin A, the various cured products, such as alfalfa hay, alfalfa-leaf meal, and alfalfa meal, vary widely in their content of this vitamin. These studies also showed that from 20 to 40 per cent of the ration for growing chicks may be made up of milo maize, provided the remainder of the diet is properly balanced.

The method of raising chickens in Arizona without any housing has continued to give good results. These experiments have attracted much attention. It was found that the confinement method of raising chicks used in many sections of the country can not be used at Glendale, or where climatic conditions are similar, unless modified, because of high chick mortality.

Experiments with various kinds of litter for use in the brooding quarters for turkeys have indicated that hay and straw are unsatisfactory for this purpose. Gravel was found to be entirely satisfactory.

Heat requirements for turkeys during the brooding period were found to be high. A temperature under the hover of 100° to 110° F. and on the wall of the brooder room of 80° to 90° was found to be essential to the comfort and safety of the poults.

BIOCHEMIC DIVISION

The work of the Biochemic Division, under M. Dorset, chief, consisted for the most part of hog-cholera investigations, chemical and bacteriological researches on problems concerning meats and meat food products, biological products used in diagnosing disease, and dips and disinfectants.

HOG-CHOLERA INVESTIGATIONS

During the year there were produced at the bureau's experiment farm at Ames, Iowa, 77,500 cubic centimeters of anti-hog-cholera serum and 31,814 cubic centimeters of virus. These products were used in the various hog-cholera experiments conducted in Iowa and near Washington, D. C., and also for the purpose of immunizing suckling pigs at eight farms controlled by the bureau in different

parts of the country. The latter work was carried out in cooperation with the Animal Husbandry Division. The immunization of suckling pigs has continued to be satisfactory. The injections of the serum have been made usually in the axillary space, and the dose has averaged approximately 20 cubic centimeters. As in previous years, a limited amount of field work has been conducted in the vicinity of the experiment farm at Ames. Such work has had for its object the collection of information which might be of value in future investigations, and also the rendering of assistance to local farmers who were experiencing trouble with hog cholera and associated diseases in their hogs.

USE OF MUSCLE EXTRACT FOR HYPERIMMUNIZATION

Experiments on the use of muscle extract for hyperimmunization, which were begun in the previous year, were carried out to a sufficient extent to permit final conclusions. The muscle extract was prepared from fresh muscular tissue obtained from the carcasses of pigs affected with hog cholera. The finely ground tissue freed from fat was mixed with sterile physiological salt solution in the proportion of 1 cubic centimeter of the solution to 1 gram of the ground muscle tissue. The mixture was allowed to stand overnight, and the fluid was then pressed out and clarified by the use of 1 per cent sterile, infusorial earth. A perfectly clear extract was obtained in this way. The extract was used for hyperimmunizing three immunes by injecting them intravenously. The muscle extract was used in one case in the proportion of 5 cubic centimeters and in the other two cases 6 cubic centimeters per pound of weight. Serums prepared from these animals were tested in doses of 15 and 20 cubic centimeters. Two of the serums so tested appeared to be slightly below the standard of potency desirable in hog-cholera serum. The tested pigs were slightly sick for a few days but recovered. The third serum appeared to give satisfactory results. The conclusions to be drawn are that anti-hog-cholera serum prepared by the use of muscle extracts obtained from virus pigs has some potency but that the use of serum of this kind is justified only in cases of emergency.

EFFECT OF HYPERIMMUNIZING DOSE ON SERUM POTENCY

An extensive series of experiments was conducted with relation to the effect of hyperimmunizing dose on serum potency. Defibrinated virus blood was used for hyperimmunizing in doses varying from 1 to 4.6 cubic centimeters per pound of body weight. Twelve immune hogs were hyperimmunized with these reduced doses and, as controls, five were hyperimmunized with the usual dose of 5 cubic centimeters per pound of weight. The virus blood used for hyperimmunizing the controls and experimental animals was the same. The results of the experiments were that potent serum was obtained from all the immunes hyperimmunized with $2\frac{1}{2}$ cubic centimeters or more of virus per pound of weight. Two immunes hyperimmunized with 1 cubic centimeter per pound of weight failed to produce potent serum. The use of a smaller dose of hyperimmunizing virus than now used would materially reduce the cost of serum production, and these experiments point strongly to the possibility of such a reduction in dose being feasible. It is believed, however, that reduced doses of virus blood

should be employed by serum-producing establishments only after thorough investigation. Although the number of hogs used in the experiments just described was large when viewed from an experimental standpoint, it was not large as compared with practice. It is hoped that this work may be repeated by others who are interested in this particular field.

STUDIES OF "VACCINATION SHOCK" IN YOUNG PIGS

During the last two years reports have been received from various sources to the effect that peculiar and sometimes alarming symptoms were occasionally observed in young pigs immediately after serum immunization. The condition, by reason of its sudden onset and the peculiar train of symptoms, was referred to as an anaphylaxis. In reported cases the symptoms varied in intensity in different animals and consisted in the main of rapid respiration, prostration, and sometimes vomiting and convulsions. Affected pigs almost always recovered within a few hours. Munce and Hoffman, after a careful series of investigations, reached the conclusion that hog serum acquired its shock-producing qualities as a result of being heated at approximately 60° C. Serum heated somewhat above 60° appeared to be more active in the production of shock than other lots heated at lower temperatures.

During the past year an extensive series of experiments was carried out in a study of vaccination shock. Approximately 275 pigs have been used in these studies, which were carried out, for the most part, on farms with young pigs weighing from 8 to 45 pounds, the dose of serum being 20 cubic centimeters administered intraperitoneally. Clear hog serum without addition of any kind was found to develop shock-inducing properties when heated at temperatures ranging from 58° to 62° C. Young suckling pigs were more sensitive than older pigs, and there appeared to be considerable variation in individual susceptibility of the injected pigs. This variation in susceptibility was more noticeable in pigs that had passed the weaning age. In no case was any serious permanent injury noticed after the attack of shock. In the case of one pig which experienced severe shock but recovered, it was possible after an interval of two days to reproduce the symptoms in almost as severe form as the first by administering a second dose of heated serum. Chemical studies of this condition are under way. It has been demonstrated rather clearly that the shock-producing material in the serum is precipitated by ammonium sulphate in the concentrations usually employed to precipitate the euglobulins. The results thus far obtained indicate that the condition of vaccination shock is not sufficiently frequent or severe to constitute a serious hazard in the immunization of young pigs. The study of this condition is being continued.

DISTRIBUTION OF VIRUS IN THE BLOOD OF CHOLERA PIGS

Studies of the distribution of virus in the blood of cholera pigs were a continuation of those reported last year. The virus in defibrinated virus blood was found to be associated, in large part at least, with blood cells. Washing the cells with seven changes of normal salt solution did not suffice to detach the virus from the cells.

It was found also that blood cells separated from normal defibrinated blood were capable of absorbing virus from diseased blood serum in vitro.

KEEPING QUALITIES OF ANTI-HOG-CHOLERA SERUM

Potency tests were made on two samples of serum, one of which was clear serum produced in 1916 and the other defibrinated blood serum produced in 1919. These serums were tested by injecting susceptible test pigs with 20 cubic centimeters of serum and 2 cubic centimeters of virus. All the test pigs remained well, whereas the controls contracted hog cholera in the usual time. These two samples of serum evidently retained their potency for 15 and 12 years, respectively.

LEUCOCYTES IN THE BLOOD OF NORMAL AND SERUM-TREATED PIGS

A study of the leucocytes of normal and diseased pigs, as well as those of pigs which were injected with serum alone and with serum and virus, was continued. In a group of 48 normal pigs the white-cell count varied from 12,000 to 39,000 per cubic millimeter. The injection of serum alone appeared to be without effect on the white-cell count, whereas in three experiments a noticeable diminution of the number of leucocytes after simultaneous treatment was noted. The decrease in the leucocytes was, in general, greater in pigs that received a small dose of serum than in those that received large doses. The effect of the dose of serum in simultaneously inoculated pigs was noted both in the degree of reduction in leucocytes and in the duration of this reaction. There appears to be a more or less constant and noticeable increase in the number of white blood cells after feeding. This is an important point to be taken into consideration in making white-blood-cell count on hogs for diagnostic purposes.

MEATS AND MEAT FOOD PRODUCTS

In collaboration with the Meat Inspection Division and the Pathological Division, the Biochemic Division completed a study of the bacteriology and keeping qualities of canned hams and certain other canned, cured pork products. Two hundred and fifty samples, representing five kinds of products produced at six different inspected establishments, were examined. The study revealed a wide variation in the keeping qualities of products of this type. Many factors were found to have an influence upon the keeping quality. In order to determine the effect of heat upon the physical condition of the contents of these canned products, a limited number of experiments were carried out in the laboratories. Although the minimum temperature at which canned, cured hams and similar products might be damaged was not accurately determined, it was found in the laboratory in a number of cases that the texture was seriously affected at temperatures above 93° C. A full report of this work has been prepared.

During the year a series of experiments, not yet completed, indicated that veal is fully as good a source of the growth-promoting vitamin G as are beef, lamb, or pork.

TUBERCULIN AND MALLEIN

The preparation and distribution of tuberculin and mallein for official use by bureau and State officials were continued. The total quantity of mallein supplied during the year was 8,370 doses, which is approximately 12 per cent less than during the preceding fiscal year.

The year's output of tuberculin was as follows: Subcutaneous tuberculin, 394,720 cubic centimeters; intradermic tuberculin, 1,817,712 cubic centimeters; ophthalmic tuberculin, 2,018,980 disks.

The total production of regular tuberculin in the three forms during the year was 11,206,220 doses. The amount of intradermic and subcutaneous tuberculin has remained about stationary, whereas there has been a marked reduction in the amount of ophthalmic tuberculin produced.

The production of tuberculin from cultures of *Mycobacterium tuberculosis* on a synthetic medium has been greatly extended during the fiscal year. This tuberculin has been supplied to inspectors for experimental testing with the idea of eventually replacing the regular tuberculin, provided that the results obtained warrant such action. The results with this tuberculin have continued to be satisfactory, and 1,552,400 doses of this product have been supplied to field inspectors of the bureau.

In connection with the distribution of tuberculin prepared from cultures on a synthetic medium, there was begun, in collaboration with the Tuberculosis Eradication Division, a special study of the effect of the concentration of tuberculin on the character of reactions produced in tuberculous cattle. This work has already proceeded far enough to demonstrate that there are certain fairly sharp limitations beyond which the dilution of tuberculin before use should not be carried. In addition, the present indications point strongly to the fact that some reduction in the concentration heretofore employed for tuberculin produced from cultures on synthetic medium may be desirable. This work is being continued.

The efforts, reported in 1930, of a manufacturing establishment in the United States to produce asparagin, which is so widely used in the cultivation of *Mycobacterium tuberculosis*, have been successful. That firm is already in a position to supply at least a part of the domestic demand. During the fiscal year 1931 it was found that ammonium malate supplies nitrogen in a form suitable for the tubercle bacillus, but is less satisfactory than asparagin.

INVESTIGATIONS OF DIPS AND DISINFECTANTS

Routine laboratory analyses were made of 71 samples of dips, disinfectants, viruses, serums, and miscellaneous products.

During the year there were prepared and forwarded to inspectors in the field the following: For testing the strength of dipping baths, 335 new outfits for arsenical dips and supplies to make 366,000 field tests; 50 new outfits for testing lime-sulphur baths and supplies to make 11,200 field tests; 6 new outfits for testing nicotine dipping baths and supplies to make 1,890 tests; and supplies to make 4,500 tests for phenol in viruses, serums, and analogous products.

Investigations of chlorine disinfectants showed that the active agent in chlorination of ammonia is hypochlorous acid and not free

chlorine. They established, also, that the characteristics of the chloroamines formed vary with the reaction. Each chloroamine at a certain degree of acidity becomes converted to ammonium salt and the next more highly chlorinated member of the series. Each chloro derivative at a certain degree of alkalinity becomes converted to chloride and free nitrogen plus a certain proportion of the next less highly chlorinated derivative, along with varying proportions of nitrogen-oxygen compounds, including nitrates, nitrites, and nitrous oxide. These studies, moreover, developed the fact that the nitrogen-chlorine compounds which effect disinfection of tannery effluents vary greatly in germicidal power and in the rates at which they act. Moreover, they are unstable, particularly under the influence of the changes in reaction which occur during treatment and storage of the chlorinated effluent. The problem of developing a practical field test to be used as a control on efficiency of disinfection has been found to be extremely complex, and progress thus far has consisted chiefly in the elimination of unsuitable methods from further consideration. This problem is being given further study.

Investigations were made of the disinfecting power of a number of cheap, readily available substances, such as sodium hydroxide, sodium carbonate, and trisodium phosphate. The effect of these substances upon *Eberthella typhi*, *Staphylococcus aureus*, *Salmonella pullorum*, *S. gallinarum*, *Pasteurella avicida*, and strains of hemolytic streptococci was determined. These studies indicated that for general disinfection, even in the presence of organic matter of various kinds, a 2 per cent solution of sodium hydroxide is effective. The addition of calcium hydroxide, to make a whitewash, adds to the effectiveness of the sodium hydroxide. For the same purposes a 2 per cent solution of sodium carbonate or 2.5 per cent solution of commercial trisodium phosphate may be used. The last two substances are more effective at ordinary temperatures if 0.5 per cent of sodium hydroxide is added. If the disinfecting solution is applied hot the addition of the hydroxide is not necessary.

The year's work determined that orthophenylphenol in soap solution, and also the calcium and sodium salts of orthophenylphenol, are effective against *Mycobacterium tuberculosis*. A solution containing 1 per cent of orthophenylphenol and 2 per cent of coconut-oil soap is effective for rapid disinfection, whereas solutions containing only half those amounts of orthophenylphenol and coconut-oil soap are effective only when contact is prolonged. Orthophenylphenol seems to offer possibilities of considerable usefulness in connection with the disinfection of dairy barns and stables during tuberculosis eradication, the disinfectant being effective and, at the same time, practically odorless. Numerous additional experiments with disinfectants were completed during the year and the results in some cases were offered for publication.

DIAGNOSTIC ANTIGEN FOR PULLORUM-DISEASE TESTING

Experiments previously begun for the purpose of obtaining a better procedure for pullorum-disease diagnosis were greatly extended. During the course of this work it was observed that one of the preservatives studied, namely, crystal violet, when used in sufficient concentration, not only aided in the preservation of the antigen but also stained the bacteria contained in it. The stained bacteria were found

to react as well in the agglutination test as the unstained organisms. It was observed, furthermore, that the staining was distinctly advantageous in facilitating the reading of the test when applied with whole blood, as described in the report for the year 1929. A description of the method of producing this new antigen was prepared for publication, and sufficient antigen to make more than 133,000 tests was distributed to investigators in various parts of the country. Many favorable reports have been received from these collaborators, and during the present fiscal year a final decision as to the value of this antigen in practical diagnostic work will probably be possible.

INVESTIGATIONS OF ANTHELMINTICS

Investigations of anthelmintics were conducted in collaboration with the Zoological Division. A study of the relation between chemical structure, physical properties, and anthelmintic efficacy of chlorinated hydrocarbons was completed. The results indicate that anthelmintic efficacy is intimately linked with water solubility and is not solely dependent upon the halogen concentration or upon the position of the halogen atoms in the molecule. Previous studies dealt almost entirely with chlorine compounds.

A series of experiments was carried out with compounds formed between the alkyl hydrocarbons and iodine and bromine. Although such compounds possess anthelmintic efficacy, they have not been found to be of greater value than the chlorinated hydrocarbons.

EXPERIMENT STATION

The work of the bureau's Experiment Station at Bethesda, Md., conducted under the supervision of W. E. Cotton, superintendent, consisted principally in investigations of infectious abortion, tuberculosis, and vesicular stomatitis, and also in providing other divisions of the bureau with facilities not available in their laboratories for carrying on some of their experiments.

INFECTIOUS ABORTION

As in the previous year, considerable attention was given to studies in immunization as a phase of the abortion problem. Five vaccine experiments, either previously begun or inaugurated within the year, received attention, and two of them were completed. The object of the first of these experiments was to determine the relative efficacy of three strains of *Brucella abortus* (also designated as *Bacterium abortus*) of different degrees of virulence, as indicated by the lesions produced by them in guinea pigs, in inducing immunity against infectious abortion, and also to determine whether the objectionable features associated with the use of virulent strains for vaccination could be materially reduced or eliminated by making use of strains of low virulence in preparing vaccine, without reducing its potency.

The results of this experiment are being prepared for publication. They indicate that each of the three strains used possessed immunizing properties and that the two strains of reduced virulence compared favorably with the most virulent strain in this respect and, moreover, possessed the distinct advantage of not becoming localized in the udders, as sometimes happens when highly virulent strains

are used. The frequency with which the vaccine made from the most virulent of the three strains localized in the udders and was eliminated in the milk of the cows definitely points out that the use of vaccines made from virulent strains of *Brucella abortus*, especially in connection with unbred cows with functioning udders, is not without risk of making them carriers of *Br. abortus*. The virulent strain of vaccine did not appear, however, to become implanted in the udders of the unbred heifers used in this experiment.

The second experiment had for its object the determination of the efficacy of vaccines prepared from a strain of *Br. abortus* nonpathogenic for both cattle and guinea pigs, when used on pregnant cattle. The results of this experiment also are being prepared for publication. Although these results show that such vaccines do not induce a high-grade immunity in cows and heifers treated during pregnancy, they nevertheless indicate that considerable protection is imparted, since 40 per cent of the vaccinated animals in the experiment completely resisted an exposure to *Br. abortus* so severe as to cause eight of nine controls to acquire the disease and abort. So far as could be determined, the use of the avirulent strain of vaccine was not attended with udder infection or other unfavorable results.

The object of the third experiment was to determine the comparative value of two avirulent *Brucella abortus* strains in protecting pregnant cattle against infection. Although this experiment has not been completed, the results obtained thus far have been similar to those obtained in the second experiment, namely, that avirulent-strain vaccine, administered during pregnancy, conferred a limited degree of protection against artificial exposure. No evidence has yet been obtained from the experiment to indicate that there is any difference in the protective effects of the two avirulent strains used.

The determination of the relative value of two avirulent strains of *Brucella abortus* and two of much reduced virulence, used two months or more before conception for protection against subsequent exposure, was the object of the fourth experiment. Results of this experiment, in which 25 head of cattle were used, although yet too incomplete to permit definite conclusions, indicate that a demonstrable degree of immunity is conferred by each of the four strains employed.

The fifth experiment, still in progress at the end of the fiscal year, is a repetition of the one in calfhood immunization, previously reported, but is on a larger scale. It involves vaccinating at a somewhat earlier age and using vaccines of moderate virulence only. Thirty-six animals are being used; half of them were vaccinated when about 4 months of age, the remaining half being used as controls. Many of the principals and controls have already been bred and will soon be exposed to *Br. abortus* infection, to determine the degree of protection afforded by the vaccination.

Additional data have been obtained relating to the transmission of abortion disease. Use has been made of the conjunctival method of exposure exclusively in four vaccine experiments to test the degree of protection afforded by the vaccinations. The method has been successful in transmitting abortion disease to 28 of the 30 unvaccinated controls used in the experiments.

Efforts to transmit abortion disease through the unbroken skin, discussed last year, were continued with the result that of the seven

pregnant cows thus exposed, four acquired the disease. Three of the four animals that acquired the disease in this manner received a single application of a few cubic centimeters of a *Brucella abortus* suspension to an area of the skin. The fourth received two applications a few weeks apart. In each case the suspension was applied to a single area about 6 inches in diameter, precaution being taken to eliminate other portals of entrance of infection. The application of *Br. abortus* suspension to the freshly abraded skin has conferred the disease with regularity.

Six chemical agents were administered to 26 cows carrying *Br. abortus* in their udders, in order to determine whether any of the agents would cause the infection to disappear from the udders. These agents were thionine, nearsphenamine, acriflavine, sodium cacodylate, pyridium, and butyl chloride. Tests of the infectiousness of the milk for guinea pigs before and after treatment showed that in no case did any of these substances appear to be of any value in overcoming *Br. abortus* infection.

In the last annual report, attention was called to the fact that guinea pigs inoculated with the blood serum from swine infected with *Br. abortus* had in a few instances acquired abortion disease from the inoculations. Further experiments with swine confirmed the preliminary results. Twelve pregnant sows and two boars were used in these experiments, each being infected with the swine type of *Br. abortus* by the conjunctival method. The blood of 10 of the sows and the 2 boars was found to be infected with *Br. abortus* by guinea-pig inoculations after the exposure. Although the infection did not appear to persist in the blood of the animals for very long, its presence was demonstrated as early as the tenth day after exposure and the blood of one sow was still found to be infected on the forty-fifth day.

The agglutination titer of the blood in which infection was found varied within wide limits. Of 23 samples which were infected, taken from the 12 animals, the titer of 2 was 1 to 50; of 10, 1 to 100; of 5, 1 to 200; of 4, 1 to 500; and of 2, 1 to 1,000.

Efforts were made during the year to gain more definite information as to the reliability of the agglutination test of blood serum, whole milk, and milk serum to determine udder infection, use being made of both the rapid and tube-agglutination methods. The milk from each quarter of the udder was tested separately, and guinea pigs were inoculated in many cases to determine the presence of abortion infection. Although the results of the agglutination tests obtained have not always agreed with those from guinea-pig injections with either cream or whole milk, they indicate that milk serum may be used with some degree of accuracy in testing for infection of the udder with *Brucella abortus*. Some doubt, however, exists as to whether it is as reliable for this purpose as the blood test when consideration is given to the titer of the blood reactions.

Much blood testing of experimental animals and of many Government-owned herds has been done, and considerable data accumulated that, it is believed, will help to bring about a better interpretation of the agglutination test and an improvement in handling infected herds.

In addition to the foregoing, several minor infectious-abortion investigations also received attention.

COOPERATIVE PROJECTS

The cooperative abortion-disease projects, commenced at the beginning of the preceding fiscal year with eight State universities and experiment stations, were continued. Definite conclusions have been reached on certain phases of some projects, and publications on them are in preparation. A project dealing with abortion in swine was added to the original projects, which include studies relative to diagnosis, control, and eradication of the disease, relative production of infected and noninfected cows, effects of dietary deficiencies, chemotherapy, immunity, and carrier problems.

TUBERCULOSIS

During the last year three experiments were concluded on the efficacy of the Calmette-Guerin method of vaccinating cattle against tuberculosis in which the vaccine (B. C. G.) was used under natural exposure. An article on the subject has been submitted for publication. The conditions of the experiments were briefly as follows: Experiment 1, one group of six animals born and maintained in a tuberculous environment, three vaccinated subcutaneously at birth with B. C. G. and yearly thereafter for three years; experiment 2, a second group of six calves born and maintained for one year in a tuberculous environment, three vaccinated by mouth with B. C. G. at birth; experiment 3, a group of four calves born under normal conditions, two vaccinated by mouth at birth with B. C. G., and all four placed in a tuberculous environment at the age of four months, for a period of eight months' exposure. Every vaccinated animal, as well as every control animal in each of these experiments, contracted tuberculosis, the extent of infection appearing to correspond to the length of exposure. There was very slight, if any, difference in the character and extent of the tuberculous lesions in favor of the vaccinated animals over the control animals. These results corroborate the bureau's previously published findings and demonstrate that the use of B. C. G. vaccine does not prevent animals from contracting tuberculosis when exposed and that lesions once established do not tend to resolve.

A second test of the avirulence of B. C. G. for guinea pigs was concluded in which 80 guinea pigs treated with B. C. G. were kept for two years in an environment free from any probable contamination with tuberculosis. None contracted tuberculosis as a result of such treatment.

A number of so-called skin lesions have been obtained from various sections of the United States in an attempt to culture the organism causing this condition and to transmit the virus to laboratory animals. All attempts gave negative results.

A questionnaire sent to various bureau veterinarians engaged in tuberculosis-eradication work furnished data showing that the majority of animals which reacted to tuberculin and in which no lesions of tuberculosis could be observed on autopsy are from herds in which tuberculosis is present. It therefore seems probable that most of such animals are affected with bovine tuberculosis though the disease has not progressed sufficiently in them to be macroscopically visible. There are instances, however, of reactors to tuberculin being found in herds in which there is no history of tuber-

culosis. An excellent opportunity was presented to study reactors of this kind during the past year. A shipment of cattle from the island of Guernsey, supposedly free from tuberculosis, when they were retested at the port of importation at Baltimore, Md., had seven reactors. Two of these reactors were autopsied at the Baltimore stockyards by bureau veterinarians, but in none were lesions of tuberculosis manifest. The remaining five reactors were sent to the experiment station for study. Shortly after their arrival they were retested with tuberculin, and three reacted. One of these reactors was slaughtered, and a careful post-mortem examination failed to reveal any lesions. Guinea pigs were inoculated with various lymph glands from this cow. Some of the guinea pigs later reacted to tuberculin but had no lesions simulating tuberculosis on autopsy. The second transfer from guinea pig to guinea pig conferred a marked sensitization to tuberculin, and an acid-fast organism was recovered from the spleen of one of the second-transfer pigs. To determine whether this organism corresponds with any of the recognized types of tubercle bacilli or is saprophytic is the object of intensive investigation.

Studies of sensitization to tuberculin in cattle by feeding cultures of various saprophytic organisms and human tuberculous sputum have been made. With the saprophytic organisms no sensitization was produced, but two of six cattle fed sputum reacted to the intradermic injection of tuberculin, indicating that some of the cases of no-visible-lesion reactors to tuberculin in dairy herds may be attributable to tuberculous attendants.

Periodic tests of tuberculin prepared by the various licensed manufacturers were made during the past year. These products were found to be satisfactory in purity and potency.

VESICULAR STOMATITIS

Because of its close similarity in many respects to foot-and-mouth disease, vesicular stomatitis has continued to be a subject of study. Two strains of virus, obtained several years ago, have been kept alive by continuous passage through guinea pigs, the one for five and one-half years and the other for four and one-half years. Both strains were recently tested on cattle and found to be still virulent for them.

Having these two strains of virus at the Experiment Station has made it possible not only to carry on studies of the disease and to type outbreaks occurring in the field, but also has enabled the bureau to supply other investigators both in this country and Europe with virus for study.

During about five months of the year facilities were afforded Kurt Wagener, of Berlin, Germany, to carry on intensive studies with vesicular stomatitis. Doctor Wagener is spending a year in this country making investigations under the Rockefeller Foundation. Having worked with Professor Waldmann at the foot-and-mouth-disease experiment station on the island of Rheims, Doctor Wagener is especially qualified to study vesicular stomatitis to determine the points of similarity and difference between it and foot-and-mouth disease. His studies yielded results that substantially advanced knowledge of the disease. He prepared several papers describing his experiments and results for publication in veterinary journals.

MISCELLANEOUS

Large numbers of experimental animals were raised for use in the researches on animal diseases, and the facilities for carrying on investigations have been improved.

FIELD INSPECTION DIVISION

The Field Inspection Division, directed by George W. Pope, chief, continued work incident to the control and eradication of certain animal diseases and the administration of regulations governing the exportation of livestock and those designed to guard against diseases of foreign origin through the importation of livestock, hides, skins, wool, and like products, feeding materials, fertilizers, used bagging, and hay and straw packing materials, etc., imported from foreign countries. The United States has continued to enjoy freedom from foot-and-mouth disease, rinderpest, contagious pleuropneumonia, surra, fowl pest, and certain other diseases prevalent in various parts of the world.

ERADICATION OF SCABIES

In the sheep-scabies-eradication work, which was continued in cooperation with State livestock sanitary officials, inspectors in the field made 21,775,139 inspections and supervised 3,788,224 dippings of sheep. Those found to be infected numbered 565,448, which is 33 per cent less than for the preceding year. An increase in the number of infected animals was reported in Colorado, South Dakota, and Texas, and a reduction was reported in Arizona, Kansas, Kentucky, Louisiana, Nebraska, New Mexico, and Wyoming. The western sheep-raising States of Idaho, Montana, Nevada, Oregon, and Washington remained free. This was likewise true of California, although San Clemente Island of that State, in which effective eradication work was conducted during the preceding year, was continued under quarantine.

The sheep-scabies situation on the Navajo Indian Reservation in Arizona and New Mexico has been greatly improved as the result of a very satisfactory season's work in cooperation with the Office of Indian Affairs, Department of the Interior. There has been little change in the scabies conditions in Mississippi, although consideration has been given by local authorities and sheep owners in the quarantined area to taking up cooperative work.

In the control and eradication of cattle scabies, bureau employees made 3,465,161 inspections and supervised 843,894 dippings of cattle in cooperation with State livestock sanitary authorities and the Office of Indian Affairs. Cattle found to be infected numbered 233,177, an increase of 161 per cent over the preceding year. The increase was caused by a large number of infected cattle in Nebraska and Texas. Two outbreaks in California, resulting from the introduction of infected cattle, were promptly eradicated. There was a reduction in the number of infected animals in Kansas, Montana, New Mexico, Oklahoma, and Wyoming. The greater number of those in Montana were on Indian reservations.

Inspectors of the bureau continued to cooperate with the Texas authorities in the inspection and dipping of goats for scabies. Goats inspected numbered 187,314, of which 4,028 were infected. Alto-

gether, 7,984 dippings were supervised. This number is about 26 per cent less than that of the preceding year.

In the control of scabies, 5,595 horses were inspected in Montana, Oregon, and Washington; 85 were infected. The number inspected is slightly less than during the preceding year. The number of infected animals, all of which were found on the Blackfeet Indian Reservation in Montana, is about 73 per cent less.

ERADICATION OF DOURINE

No case of dourine was reported during the year from the Navajo Indian Reservation in Arizona and New Mexico, and it is believed that this area is now free from the disease. A considerable amount of preliminary testing was done in southwestern Idaho and southeastern Oregon to determine the location and extent of dourine, which is apparently now confined to those sections south of the Owyhee River. These localities and northern Nevada, in which the disease exists and where much work has been done, are held under State quarantines. As the infected areas in these three States join and consist principally of open range, it was considered advisable to defer systematic eradication throughout this territory until the State authorities are prepared to conduct effective work simultaneously, including the disposal of wild horses that can not be rounded up on the range and tested.

On the San Carlos Indian Reservation in Arizona, where dourine is believed to exist extensively, much preliminary work was done during the year in cooperation with the Office of Indian Affairs, preparatory to taking up systematic eradication. This will be a difficult task, as the horses and ponies on this reservation are wild, and the topography of the country is rough.

As a result of the complement-fixation test applied to a large number of blood samples from horses, 18 reactors were found in Idaho, 3 in Oregon, and 2 in Nevada. A complete report of the animals tested and the results of the tests appears on page 54.

INTERSTATE SHIPMENTS OF LIVESTOCK

Bureau veterinarians, in connection with their regular duties, inspected 1,635 horses and mules and tested 1,086 with mallein for glanders. None of the animals reacted to the test. These inspections were made and tests administered for interstate movement, and certificates were issued to conform to the requirements of the livestock sanitary authorities of the States of destination. Inspectors in the field, in connection with their regular duties, also made other inspections of livestock and issued certificates to conform to State requirements.

CONTROL OF COMMUNICABLE POULTRY DISEASES

The bureau continued to supervise the cleaning and disinfection of poultry cars, as has been done for several years recently at the request of live-poultry transportation companies. This work was accomplished for the most part at three principal poultry-car cleaning and disinfecting establishments, and 13,522 cars were treated. No outbreak of fowl pest or similar serious diseases of poultry was reported during the year.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS

A careful inspection was made of all horses, ruminants, and swine from foreign countries when they were presented for entry at coast or border ports. The importation of cattle and other domestic ruminants and swine from countries infected with foot-and-mouth disease or rinderpest is prohibited by a specific act of Congress. As foot-and-mouth disease is prevalent in most countries of the Eastern Hemisphere and South America and since outbreaks occurred during the year in England, Scotland, and Ireland, importations of cattle, sheep, goats, and swine were practically limited to those from Canada, Mexico, and the Channel Islands.

On March 1, 1931, an order became effective governing the movement of livestock between the United States and Mexico. This order, constituting special regulations, was issued under authority of a treaty ratified by the two Governments on January 17, 1930.

Necessary repairs were made to the quarantine-station properties at Boston, New York, and Baltimore.

The number and kind of animals imported are shown in Tables 1 and 2.

TABLE 1.—*Imported animals inspected but not quarantined, fiscal year 1931*

Port of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Other animals
Baltimore.....					21	1	10
Boston.....					43	1	6
Key West.....					626		
Los Angeles.....					34		
Miami.....						1	
New Orleans.....	8						
New York.....					840	24	7
Norfolk.....					1		
Philadelphia.....					6		
Tampa.....					9		
San Juan, P. R.....	1,952	271	17	39	92	6	6
Canadian border ports.....	23,810	927	2,692	21	10,749	1	480
Mexican border ports.....	67,408		3,932	64	4,572	3	132
Total.....	93,178	1,198	6,641	124	16,993	37	641

¹ Of this number 2,980 were mules.

NOTE.—Not included in this table were 4,723 cattle and 1 horse inspected at time of entry and passed through the United States in bond.

TABLE 2.—*Imported animals inspected and quarantined, fiscal year 1931*

Port of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Other animals
Boston.....			63			2	18
New Orleans.....							1
New York.....	413		7		4	5	76
San Francisco.....			42		23		12
San Juan, P. R.....					1		7
Seattle.....							2
Canadian border ports.....	13	2		1			
Total.....	426	2	112	1	28	7	116

¹ Includes six musk oxen from Greenland via Norway.

The bureau's inspectors at Mexican border ports, in cooperation with the Bureau of Biological Survey, inspected and supervised the quarantine of 39,710 quail for importation from Mexico.

Importations of live poultry amounting to 883 fowls were inspected at time of entry. These came from various countries, including Canada, England, Scotland, Ireland, Australia, Japan, China, and India.

A total of 416 cattle from Mexico were refused entry at border ports owing to scabies infection and tick infestation; 51 tick-infested mules also were rejected.

Of seven cattle rejected at Canadian border ports, six had infected udders and one was affected with antinomycosis. One horse suffering from strangles was refused entry.

Inspectors at coast ports continued to give especial attention to the enforcement of regulations designed to prevent vessels from entering ports of the United States with sea-stores livestock which originated in countries in which either foot-and-mouth disease or rinderpest exists. During the year 27 vessels carrying prohibited livestock were held pending slaughter of the animals and disinfection of that section of the vessel occupied by them. These animals consisted of 2 cattle, 20 swine, 20 sheep, and 2 goats. Excellent cooperation was received from officers of the customs service of the Treasury Department and from officials of the Public Health Service, who boarded vessels in connection with their quarantine duties. The bureau is greatly indebted to these officials who during the year obtained declarations from 13,291 shipmasters relative to the possible presence on their vessels of prohibited livestock and animal products.

IMPORTATION OF ANIMAL BY-PRODUCTS, FEEDING MATERIALS, ETC.

Throughout the year especial care was taken in the administration of regulations governing the sanitary handling and control of import animal by-products, feeding materials, and other merchandise that might serve as possible carriers of livestock diseases into the United States. Although in the case of animal by-products there is an element of danger from anthrax, the matter of chief concern has been the possibility of these and other materials carrying the infection of foot-and-mouth disease.

Hides, skins, wool, hair, tankage, glue stock, and other like animal by-products, when not accompanied by proper certificates, were kept under careful supervision and allowed movement only under seals to establishments approved for their handling, segregated storage, and disinfection in process of manufacture. The utmost care was taken with feeding materials from infected countries and, if not properly certified at time of shipment, the materials were held under quarantine for 90 days in addition to being subjected to other effective restrictive measures.

Previously used bags and bagging from countries in which foot-and-mouth disease exists were subjected to disinfection by heat at the port of entry or otherwise shipped in sealed cars to approved mills for segregated storage and disinfection in process of manufacture into paper.

Bureau inspectors at ports of entry continued to maintain a careful supervision over vessels arriving at United States ports with provisions of fresh or frozen meats obtained in regions in which foot-and-mouth disease exists. Every effort was made in the instance of such vessels to enforce strictly a special order of the department against the landing and feeding of garbage which might contain scraps of infected meat. Surgeons of the Bureau of the Public Health Service and customs officers at ports of entry were very helpful in cooperative measures for the enforcement of this order.

Owing to a possibility that the feet of dressed poultry from infected countries may find their way into garbage and be fed to domestic swine, care was taken to enforce the order requiring the removal and destruction of the feet of all such poultry. Although it was found that in most instances the feet had been removed before shipment, it was necessary, in 15 boxes of dressed turkeys and 292 cases of guinea fowls, to require removal of the feet after the arrival of these shipments in the United States.

It became necessary during the year to place restrictions on glands of cattle imported from certain countries for use in the manufacture of biological products. This was accomplished through cooperation of manufacturers in a manner to minimize danger of introducing disease and at the same time to render continued importation possible. Supervision and restrictions were continued over importations of calf stomachs for use in the manufacture of rennet.

During the year 5,202 cars used in the transportation of restricted import products were cleaned and disinfected.

INSPECTION OF ANIMALS FOR EXPORT

On September 1, 1930, new regulations became effective governing the inspection and certification of export animals. These regulations, constituting B. A. I. Order 322, superseded former regulations which required modification. This was due to inclusion of domestic live poultry under the law and to changed conditions relating to the exportation of livestock; dairy and breeding animals, rather than those for slaughter as in former years, now chiefly constitute shipments.

All export livestock including domestic live poultry were inspected as provided by law, and all vessels used in transportation were inspected as to space, fittings, and equipment for the humane treatment and safe transport of the animals. Every possible effort was made to accomplish such inspections and tests and as far as conditions warrant to issue certificates as might be specified by regulations of foreign receiving governments, this being in addition to the requirements of the United States.

Beginning with March 1, 1931, exportations to Mexico were inspected and certified as provided by special regulations contained in B. A. I. Order 327, issued under a convention between the United States and Mexico ratified on January 17, 1930.

The number of animals of various kinds inspected for export is shown in Table 3.

TABLE 3.—*Inspection and testing of animals for export, fiscal year 1931*

Kind of animal	To Canada	To other countries		Total
		American animals	Canadian animals ¹	
Cattle.....	499	1, 909	154	2, 562
Swine.....	118	483	-----	601
Sheep.....	2, 068	1, 831	-----	3, 899
Goats.....	30	421	-----	451
Horses.....	568	3, 250	4	3, 822
Mules.....	79	6, 779	-----	6, 858
Asses.....	-----	22	-----	22
Other animals.....	-----	4	-----	4
Total.....	3, 362	14, 699	158	18, 219

¹ Animals of Canadian origin exported through United States ports.

The following fur-bearing animals were inspected and certified for export: 400 minks destined to Sweden, 150 minks and 132 badgers destined to Norway, 3 foxes destined to Denmark, 50 foxes destined to the Netherlands, and 1 fox destined to Australia.

An inspection was made of 28,393 fowls consisting of chickens, ducks, turkeys, geese, pigeons, swans, and guinea fowls. These were exported principally to Canada and Mexico, a few going to Japan, China, and Central and South America, Cuba, and New Zealand.

DIVISION OF HOG-CHOLERA CONTROL

Under the supervision of U. G. Houck, chief of the division, the control of losses in swine from hog cholera was continued as a project of the bureau during the year, in cooperation, as heretofore, with State livestock authorities, practicing veterinarians, and farmers.

Approximately 35 bureau veterinarians devoted their time to the various control and educational activities, such as holding meetings and demonstrations among farmers, making surveys, investigating outbreaks of swine diseases, and giving general advice to swine owners.

In the way of educational activities, bureau veterinarians assigned to hog-cholera work addressed 524 meetings, which were attended by 88,719 persons interested in the prevention of hog cholera, and held 1,460 demonstrations in the use of the preventive-serum treatment. In the line of control work the veterinarians made 23,224 visits to farms, 5,771 on call and 17,453 for survey and for information. They interviewed 68,842 swine owners, veterinarians, and others, and held 3,011 autopsies for the purpose of making diagnoses. There were quarantined or carded 372 infected farms, and 380 farms were cleaned and disinfected under supervision.

The number of outbreaks of hog cholera brought to the attention of bureau inspectors during the year was 3,388, which is a considerable reduction as compared with 4,162 during the year immediately preceding. The mortality rate from the disease during the year is estimated as the lowest since the department has kept records. The work was conducted in 944 counties of 30 States.

In addition to the activities mentioned, bureau inspectors made a general survey of prevailing conditions as they pertained to hog cholera and other swine diseases. Radio addresses based on the information thus obtained were broadcast by the chief of the division.

The information also was made available to the press, which gave it further distribution.

Representatives of the division in Washington made several trips to field stations during the year in a supervisory capacity, after which timely information on conditions found and the important phases of hog-cholera control was furnished to swine owners and the public. Table 4 gives additional data on the year's activities.

TABLE 4.—*Summary of hog-cholera-control work, fiscal year 1931*

State	Bureau veterinarians engaged in work ¹	Meetings addressed	Premises investigated	Demonstrations		Autopsies performed	Farms quarantined or carded	Farms cleaned and disinfected	Out-breaks reported to bureau veterinarians
				Number	Hogs treated				
Alabama.....	1	7	1,317	55	419	6			5
California.....	.1		43	2	60	21	8		9
Colorado.....	.5	14	162			85			41
Florida.....	1.5	9	940	276	6,093	67			96
Georgia.....	1.33	6	473	94	1,908	10			127
Idaho.....	.33	14	927	35	925	68	34	34	34
Illinois.....	3	15	2,202	16	969	847	15	305	561
Indiana.....	2	47	828			143	18		126
Iowa.....	3	68	816	5	289	186			357
Kansas.....	.8	1	747	1	13	19			11
Kentucky.....	2	22	1,935	9	324	103		9	66
Louisiana.....	1	1	391	61	1,273	13			88
Maryland.....	2	105	1,992	9	253	137	59	1	184
Michigan.....	2		1,321	22	827	110		1	225
Mississippi.....	1.03	21	961	386	2,780	18		14	20
Missouri.....	1	25	568	21	666	75		2	37
Montana.....	.1		135	10	101	103	24	5	25
Nebraska.....	.5		250			140			60
North Carolina.....	1	29	523	45	3,002	85	3		30
Ohio.....	2	31	506	5	269	141			419
Oklahoma.....	2	7	999	10	195	66	63		67
Oregon.....	.33	18	211	8	222	20	12		19
South Carolina.....	1		315	213	4,414	16			106
South Dakota.....	1	4	242	9	372	197			197
Tennessee.....	1	8	715	5	31	28	11	1	122
Texas.....	1		489	1	100	21	25	2	143
Virginia.....	1	17	2,152	15	66	46			12
Washington.....	.66	30	341	6	229	45	8		29
West Virginia.....	.25	6	101	47	536	15			43
Wisconsin.....	1	17	624	94	2,816	180	92	6	129
Total.....	35.43	524	23,226	1,460	29,152	3,011	372	380	3,388

¹ Fractions denote veterinarians devoting part time to hog-cholera work.

MEAT INSPECTION DIVISION

The work of the Federal meat-inspection service under the direction of R. P. Steddom, chief, was conducted in the usual extensive manner, involving a total of 74,406,360 animals slaughtered under inspection during the year. Although this was a decrease of 0.69 per cent as compared with the preceding year, it was 1.98 per cent more than the average of the last 10 years.

GENERAL MEAT INSPECTION

Inspection was conducted at 811 establishments in 278 cities and towns as compared with 804 establishments in 259 cities and towns during the fiscal year 1930. Inspection was inaugurated at 43 establishments and withdrawn from 50, as compared with 29 and 36, respectively, during the preceding year. Inspection was withdrawn from 49 establishments on account of discontinuance of operation or interstate business, and from 1 establishment on account of insanitary condition. At the close of June 30, 1931, there were 761 establishments in 261 cities and towns operating under inspection.

ANTE-MORTEM AND POST-MORTEM INSPECTIONS

The results of the ante-mortem and post-mortem inspections are given in Tables 5 to 10, inclusive.

Tables 7, 8, and 9 show the diseases and number of condemnations on ante-mortem and post-mortem inspections.

TABLE 5.—*Ante-mortem inspection of animals, fiscal year 1931*

Kind	Passed	Suspected ¹	Condemned ²	Total
Cattle.....	8,007,489	204,918	2,796	8,215,203
Calves.....	4,712,859	7,601	2,051	4,722,511
Sheep and lambs.....	17,297,349	5,557	6,492	17,309,398
Goats.....	9,360	12	30	9,402
Swine.....	43,932,999	97,104	17,355	44,047,458
Horses.....	135,129	30	377	135,536
Total.....	74,095,185	315,222	29,101	74,439,508

¹ "Suspected" is used to designate animals suspected of being affected with disease or condition that may cause condemnation in whole or in part on special post-mortem inspection.

² For additional condemnations, see Tables 6 to 10, inclusive.

TABLE 6.—*Post-mortem inspection of animals, fiscal year 1931*

Kind	Passed	Condemned	Total
Cattle.....	8,156,271	52,244	8,208,515
Calves.....	4,723,119	9,133	4,732,252
Sheep and lambs.....	17,281,891	18,541	17,300,432
Goats.....	9,292	77	9,369
Swine.....	43,898,857	121,776	44,020,633
Horses.....	134,503	653	135,159
Total.....	74,203,936	202,424	74,406,360

TABLE 7.—*Diseases and conditions for which condemnations were made on ante-mortem inspection*

Cause of condemnation	Cattle	Calves	Sheep and lambs	Goats	Swine	Horses
Anthrax.....					4	
Blackleg.....	2	4				
Bone diseases.....		1			5	
Carcinoma.....	5					
Dropsical diseases.....			2			
Emaciation.....	5	1	2		10	
Empyema.....	1					
Enteritis.....	1				6	
Fistula.....						23
Hog cholera.....					1,035	
Immature.....		34			1	
Influenza.....					9	
Injuries.....	3	1	1		3	
Mammitis.....	1					
Metritis.....	4					
Moribund.....	2,748	1,999	6,462	30	14,891	351
Necrobacillosis.....					15	
Parturient paresis.....	2					
Peritonitis.....					1	
Pneumonia.....	5	1	3		59	
Pyemia.....			1		11	
Pyrexia.....	7	6	14		1,029	
Railroad sickness.....	1		5			
Septicemia.....	4				16	1
Tetanus.....	3	3			1	2
Tumors and abscesses.....	1	1			229	
Typanites.....	2					
Uremia.....	1		2			
Total.....	2,796	2,051	6,492	30	17,355	377

TABLE 8.—*Diseases and conditions for which condemnations were made of the entire carcass on post-mortem inspection*

Cause of condemnation	Carcasses of—					
	Cattle	Calves	Sheep and lambs	Goats	Swine	Horses
Actinomycosis	428	21				
Anaplasmosis	46	6				
Anthrax					154	
Arthritis and other bone diseases	137	155	433		6,495	
Asphyxia	1	4	14		829	
Blackleg	12	13				
Caseous lymphadenitis			1,968	1		
Cellulitis			1		14	
Contamination	1	13	1		1,028	
Cysticercosis	99	21	280	1		
Dropsical diseases	60	2	15		56	
Emaciation	5,793	1,378	3,776	32	504	93
Frozen					3	
Gangrene	9		2		2	
Glanders						1
Hog cholera					14,365	
Hydronephrosis		1	2		24	
Icterus	90	210	1,290		4,420	
Immaturity		3,013				
Injuries	2,376	523	926	2	1,656	30
John's disease	5					
Leukemia	1,094	43	17		248	2
Melanosis	39	74	45		124	200
Moribund	3	3	4		46	
Necrobacillosis	32	1	1			
Necrosis	7	26	1		32	
Parasitic diseases	56		6		47	2
Phlebitis		81				
Pneumonia, peritonitis, enteritis, pleurisy, etc.	12,243	2,316	7,644	3	26,492	135
Pregnancy and recent parturition	74		2	34	12	2
Septicemia, pyemia, uremia	5,408	776	1,862	4	21,112	62
Sexual odor					3,365	
Skin diseases			13		73	
Splenic fever	15	35				
Strangles						44
Tetanus	1					
Toxemia	3		7			
Tuberculosis	20,455	374	3		38,895	
Tumors and abscesses	3,757	44	228		1,812	82
Total	52,244	9,133	18,541	77	121,776	653

TABLE 9.—*Diseases and conditions for which condemnations were made of parts of carcasses on post-mortem inspection*

Cause of condemnation	Parts of carcasses of—				
	Cattle	Calves	Sheep and lambs	Swine	Horses
Actinomycosis	90,689	1,903		4	
Bone diseases	18	6	21	78	
Caseous lymphadenitis			28		
Cellulitis	2			688	
Contamination	50	57	46	1,906	
Injuries	910	93	82	34,719	6
Melanosis	18	8	1	5	1
Necrobacillosis	2		3	1	
Necrosis	278	3	23		
Tuberculosis	29,741	490		329,062	
Tumors and abscesses	9,545	3,840	173	454,448	8
Total	131,253	6,400	377	820,861	15

In addition to the above parts, 573,347 cattle livers and 24,113 calf livers were condemned on post-mortem inspection.

Table 10 shows the total combined condemnations on ante-mortem and post-mortem inspections.

TABLE 10.—*Summary of condemnations*

Kind	Animals and carcasses	Parts of carcasses	Kind	Animals and carcasses	Parts of carcasses
Cattle.....	52, 311	131, 253	Swine.....	124, 247	820, 861
Calves.....	9, 191	6, 400	Horses.....	679	15
Sheep and lambs.....	18, 638	377	Total.....	205, 143	958, 906
Goats.....	77	-----			

INSPECTION OF MEAT AND PRODUCTS

The inspection and supervision of meat and products prepared and processed are shown in Table 11, which is a record only of inspection performed and not a statement of the actual quantity prepared. The record of inspection is sometimes duplicated when the product is reinspected during the different stages of preparation.

To facilitate interstate delivery of meats and products market inspection was conducted in 25 cities.

TABLE 11.—*Meat and meat food products prepared and processed under supervision, fiscal year 1931*

Product	Inspection pounds ¹	Product	Inspection pounds ¹
Cured:		Lard stearin.....	1, 209, 406
Beef.....	116, 562, 923	Compound and other substitutes for lard.....	482, 481, 941
Pork.....	2, 851, 938, 248	Oleo stock and edible tallow.....	66, 377, 805
All other.....	1, 346, 444	Oleo oil.....	98, 161, 586
Sausage.....	697, 798, 028	Oleo stearin.....	48, 385, 489
Canned:		Oleomargarine.....	117, 818, 597
Beef.....	190, 405, 629	Miscellaneous.....	1, 924, 305, 464
Pork.....	65, 330, 348	Horse meat:	
All other.....	4, 879, 142	Cured.....	9, 892, 493
Product passed for cooking:		Chopped.....	450, 520
Beef.....	2, 157, 145	Canned.....	22, 932, 265
Pork.....	6, 317, 942	Oil.....	2, 460, 129
All other.....	19, 595	Miscellaneous, smoked.....	1, 362
Pork to be eaten uncooked.....	61, 350, 171	Total.....	8, 444, 694, 842
Meat extract.....	128, 198		
Lard.....	1, 662, 397, 361		
Lard oil.....	9, 586, 611		

¹ This term represents the total volume of inspection. The figures do not represent actual production, as the same product may have been inspected and recorded more than once in the process of manufacture.

NOTE.—The following quantities of meat and meat food products were condemned on reinspection and destroyed for food purposes on account of having become sour, tainted, unclean, rancid, or otherwise unwholesome: Beef, 1,630,333 pounds; pork, 5,097,495 pounds; mutton and lamb, 41,094 pounds; veal, 34,459 pounds; goat meat, 93 pounds; horse meat, 16,080 pounds; total, 6,819,554 pounds.

MEATS AND PRODUCTS CERTIFIED FOR EXPORT

During the fiscal year 66,436 official meat-inspection certificates were issued to cover the exportation of the following products: Beef and beef products, 106,471,354 pounds; mutton and lamb and mutton and lamb products, 3,040,838 pounds; pork and pork products, 783,557,844 pounds; horse-meat products, 9,141,589 pounds; total,

902,211,625 pounds. There were also issued 4,247 certificates covering the exportation of 54,542,139 pounds of inedible animal products.

EXEMPTION FROM INSPECTION

The provisions of the meat-inspection law requiring inspection usually do not apply to animals slaughtered by a farmer on the farm or to retail butchers and dealers supplying their customers. The retail butchers and dealers, however, in order to ship meat and meat food products in interstate or foreign commerce, are required to obtain certificates of exemption. The number of such certificates outstanding at the close of the year was 1,183. During the year 84 certificates were canceled on account of dealers' retiring from business or ceasing to make interstate shipments, change of address, insanitary conditions, violations of the meat-inspection regulations, handling inspected meat only, and being granted inspection.

During the year 45,878 shipments were made by retail butchers and dealers holding certificates of exemption as compared with 45,411 shipments during the fiscal year 1930. The shipments of the year covered products as shown in Table 12.

TABLE 12.—*Shipments by retail butchers and dealers under certificates of exemption, fiscal year 1931*

Product	Car-casses	Pounds	Product	Car-casses	Pounds
Cattle (56 quarters).....	14	7, 475	Cured meats.....	-----	507, 715
Calves.....	17, 274	1, 646, 415	Lard.....	-----	9, 034
Sheep and lambs.....	22	1, 037	Sausage.....	-----	99, 924
Swine.....	11	697	Miscellaneous (head cheese, suet, scrapple, compound, etc.).....	-----	23, 424
Beef, fresh.....	-----	1, 926, 740	Total.....	17, 321	5, 005, 990
Veal, fresh.....	-----	147, 627			
Mutton and lamb, fresh.....	-----	416, 360			
Pork, fresh.....	-----	219, 542			

During the year 70,745 interstate shipments were made of meat and meat food products from animals slaughtered by farmers on the farms, as compared with 62,299 shipments made during the fiscal year 1930. The products composing these shipments are shown in Table 13.

TABLE 13.—*Shipments of farm-slaughtered meat and products, fiscal year 1931*

Product	Car-casses	Pounds	Product	Car-casses	Pounds
Cattle (165 quarters).....	41	13, 611	Pork, fresh.....	-----	104, 550
Calves.....	67, 689	5, 502, 983	Cured meats.....	-----	433, 752
Sheep and lambs.....	9, 116	300, 641	Lard.....	-----	8, 506
Goats.....	236	2, 705	Sausage.....	-----	126, 798
Swine.....	2, 556	86, 668	Miscellaneous (scrapple, livers, etc.).....	-----	17, 291
Beef, fresh.....	-----	38, 307	Total.....	79, 638	6, 685, 122
Veal, fresh.....	-----	43, 313			
Mutton and lamb, fresh.....	-----	6, 027			

INSPECTION OF IMPORTED MEAT

Table 14 shows the inspection of imported meat and meat-food products for the fiscal year.

TABLE 14.—*Imported meat and meat-food products inspected and passed, fiscal year 1931*

Country of origin	Fresh and refrigerated meat		Canned and cured meat	Other meat products	Total weight
	Beef	Other classes			
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Argentina.....			8,766,370	2,207,081	10,973,451
Australia.....	42,701	157,454	12	38,735	238,902
Brazil.....			2,854,112	146,646	3,000,758
Canada.....	666,557	733,955	1,939,301	1,324,173	4,663,986
New Zealand.....	1,832,668	422,761	240	232,072	2,487,741
Paraguay.....			2,793,193	10,350	2,803,543
Uruguay.....			6,871,121	270,573	7,141,694
Other countries.....	70,787		630,234	1,421,879	2,122,900
Total.....	2,612,713	1,314,170	23,854,583	5,651,509	33,432,975

Table 15 shows the quantities of foreign meat and products excluded from the country because of unsoundness, presence of prohibited preservatives, or other failure to comply with the regulations.

TABLE 15.—*Imported meat and meat food products condemned and refused entry*

Product	Condemned	Refused entry
	<i>Pounds</i>	<i>Pounds</i>
Beef.....	9,270	256,549
Veal.....	1,012	96
Mutton and lamb.....		6,098
Pork.....	2,413	23,368
Total.....	12,695	286,111

IMPORTATION OF ANIMAL CASINGS

During the fiscal year foreign animal casings were admitted as follows: On certification, 14,043,020 pounds; on disinfection, 1,067,176 pounds; dried casings, 9,917 pounds; total, 15,120,113 pounds. Casings amounting to 15,857 pounds offered for importation were rejected and removed from the United States.

INSPECTIONS FOR OTHER BRANCHES OF THE GOVERNMENT

By request of other branches of the Government, reinspections of meat and meat-food products were conducted, as shown in Table 16, to determine whether the articles remained wholesome and conformed to certain specifications.

TABLE 16.—*Inspections for other branches of the Government, fiscal year 1931*

Branch of Government	Passed	Rejected
	<i>Pounds</i>	<i>Pounds</i>
Navy Department.....	47, 659, 461	1, 206, 872
Veterans' Bureau.....	3, 691, 024	137, 331
Department of Justice (Federal penitentiaries).....	2, 781, 783	48, 851
Marine Corps.....	2, 264, 673	44, 452
War Department (Army Engineer Corps).....	1, 084, 175	85, 723
Department of Interior (Indian Affairs).....	756, 442	1, 274
Public Health Service.....	475, 865	21, 307
Coast Guard.....	315, 823	8, 549
Department of Agriculture (Forest Service).....		45, 195
Shipping Board.....	41, 145	302
National Homes.....	5, 050	
Alaska Engineering Commission.....	2, 591	206
Total.....	59, 078, 032	1, 600, 062

MEAT-INSPECTION LABORATORIES

Analyses and examinations of meat and products were conducted in the meat-inspection laboratories situated in the several districts throughout the country.

The total number of products examined was 46,019. A total of 2,440 products were found to be not in accordance with the regulations. Included in these were meats and meat-food products, edible fats and oils, cereals, spices, curing materials, colors, denaturing oils, water supplies, and miscellaneous articles.

Close supervision was given to meat and meat-food products offered for importation from foreign countries. More than one-fourth of the products offered for importation and examined by the laboratories failed to meet the requirements of the regulations in some particular.

About 1,700 samples of water were examined for evidence of pollution. All findings of pollution were followed by corrective action. Widespread drought conditions materially increased the difficulty of maintaining supervision over water supplies. Notwithstanding the adverse conditions, the purity of the water supplies of inspected establishments was maintained without any lowering of standards or tolerance of unclean or impure water.

The composition and keeping qualities of canned whole hams and canned chopped pork products, and the canning methods applied to such products, were given considerable attention, and a large number of analyses were made.

Analyses were made of a considerable number of baked hams and of hams so treated as to have a superficial resemblance to baked product.

LABELING MEAT AND MEAT-FOOD PRODUCTS

During the year more than 20,000 labels and other markings for meat and products were approved, and 1,742 failed of approval, principally because of the inclusion of false or misleading statements. The recent legislation affecting the classification of oleo-margarine necessitated an exhaustive study of the proper labeling of this product. Further legislation prescribing the maximum tint

or shade of oleomargarine not taxable as a colored article induced investigation involving labeling to determine the effect which fat constituents of lighter shades may have upon the vitamin content. The addition of newly devised substances purporting to assist emulsification and to reduce spattering properties of oleomargarine involved special consideration as to labeling. Frequent proposals to apply such terms as "roasted," "baked," "barbecued," and "toasted" to labels of various products were given repeated attention, and the labeling was restricted to products to which the terms were found to be appropriate. Terms denoting grading or encroachment upon official grading symbols were restricted to products actually graded by the Bureau of Agricultural Economics of this department. There were encountered repeated endeavors to apply to labels of meat-food products statements alleging curative or disease-preventing properties.

PACKERS AND STOCKYARDS DIVISION

The work of the Packers and Stockyards Division was conducted during the year under the direction of A. W. Miller, chief. It involved, under the packers and stockyards act, supervision over the operations and practices of the packers, stockyard companies, market agencies, and dealers, and rates and charges for stockyard services. Under the livestock-quarantine laws and regulations, the work involved the inspection of all livestock received at public stockyards, the enforcement of the 28-hour law, and cooperation with the various States in the application of their laws and regulations designed to prevent the introduction of animal diseases.

FORMAL PROCEEDINGS UNDER THE PACKERS AND STOCKYARDS ACT

A summary of formal dockets, in which proceedings were instituted or cases decided during the fiscal year involving violations of the provisions of the act or the reasonableness of rates and charges for stockyard services, is given in the following statement:

FORMAL DOCKETS

Pending July 1, 1930.....	13
Instituted July 1, 1930, to June 30, 1931.....	36
Final action taken July 1, 1930, to June 30, 1931.....	33
Pending June 30, 1931.....	16

SUBJECT MATTER OF DOCKETS

Stockyard rates.....	6
Commission rates.....	4
Solvency.....	11
Trade practices.....	10
Bonds.....	17
Reparation.....	1

FORM OF ACTION

Cease and desist orders.....	8
Cease and desist and suspension orders.....	15
Reparation awarded.....	1
Orders of suspension.....	6
Dismissed.....	3

Of the 36 dockets instituted during the year, final action was taken on 28. The details of each of the formal dockets are given in a separate publication which may be had on request to the bureau.

CASES IN COURT PERTAINING TO THE PACKERS AND STOCKYARDS ACT

On February 24, 1931, the Acting Secretary issued an order in Docket No. 330 against a number of market agencies and dealers at the St. Louis National Stockyards requiring them to cease and desist from certain unfair and discriminatory practices and suspending their registrations for a period of 90 days. The respondents filed a petition with a statutory court of three judges to restrain the Secretary from the enforcement of this order. On March 21, 1931, the statutory court, sitting at Danville, Ill., issued a restraining order, temporarily enjoining the order of suspension. The remainder of the Secretary's order was allowed to stand with the proviso that the respondents carry on business relations with the boycotted agencies in the usual course of business under conditions similar to those observed in dealing among themselves. At the close of the fiscal year a hearing before the court on the merits of the petition with a view to issuing a final order had not been held.

On April 27, 1931, the case of the Union Stockyards Co. of Omaha, plaintiff, *v.* T. G. Inghram, defendant, was heard before the District Court of the United States for the District of Nebraska, Omaha division. This case involved a failure on the part of the defendant to pay the rates and charges specified in Supplement No. 2 to Schedule No. 2 of the stockyard company's schedule of charges for stockyard services. The Secretary of Agriculture, in Docket No. 208 which arose on a complaint of Mr. Inghram, held that the provisions of this supplement were not unjustly discriminatory and dismissed the complaint. Mr. Inghram refused to pay the charges thereafter, and in the suit above mentioned the court held that the action of the Secretary of Agriculture in Docket No. 208 in dismissing the complaint of Mr. Inghram was not illegal, unreasonable, or arbitrary. The court further held that as the issues were the same as those presented to the Secretary of Agriculture in Docket No. 208, and had been ruled upon by the Secretary in that case, the court was without jurisdiction to review such ruling. The court then decided in favor of plaintiff and ordered the defendant to pay over the sum which the plaintiff alleged to be due.

STOCKYARDS

During the year 20 stockyards were posted as coming within the jurisdiction of the act, and 2 were released. Of the yards posted during the year 14 are located in Kentucky and are operated as auction markets. At the close of the year the number of stockyards posted under the act was 91.

REGISTRATIONS

The status of the active registrants on June 30, 1931, is shown in Table 17.

TABLE 17.—*Number of commission men and other market agencies and dealers registered on June 30, 1931*

Class	Number of agencies handling—						Total
	All species	Cattle	Hogs	Sheep	Horses and mules	Other	
Market agencies:							
Commission men.....	742	2	2	11	13	62	832
Other buyers.....	157	62	36	10	2	79	346
Clearing agencies ¹							53
Miscellaneous ²							190
Total market agencies.....							1,421
Dealers:							
Buyers.....	810	522	228	135		342	2,037
Traders.....	147	521	163	28	10	111	980
Buyers and traders.....	38	39	5	3		27	112
Miscellaneous.....	34	18			5	15	72
Total dealers.....							3,201
Total registrants.....							4,622

¹ Does not include commission men and order buyers who render clearing services.² Does not include commission men and order buyers who render miscellaneous services.

During the year 346 market agencies and 632 dealers were registered and 217 market agencies and 605 dealers were placed on the inactive list.

RATES AND CHARGES

Very few changes were made in rates and charges for stockyard services during the year other than the usual changes in feed charges resulting from market fluctuations. All changes were scrutinized, and if a proposed increase did not seem warranted, the stockyard owner or market agency was requested to withdraw the tariff. If that was not done, or the reason for the increase was not satisfactorily explained, the bureau recommended formal proceedings for the purpose of determining the reasonableness of the rates.

During the year hearings as to the reasonableness and lawfulness of rates and charges for stockyard services at Kansas City, Mo., and National Stock Yards, Ill., were held, and oral arguments were presented to the Secretary. A hearing as to the reasonableness and lawfulness of the rates and charges of the market agencies at the Kansas City market was held, and oral argument was presented to the Secretary. Oral argument was also made before the Secretary in the case involving the reasonableness of charges made by market agencies at the Sioux City, Iowa, market, and a hearing involving the reasonableness of the rates and charges of the market agencies at the South St. Joseph, Mo., market was commenced. Valuation of the stockyard properties and an audit of the books of the Union Stock Yards Co. of Omaha, and an audit of the books of the market agencies at the South St. Paul market were made with the view of holding hearings as to the reasonableness of the rates and charges at these markets.

BONDS

Market agencies and dealers generally have complied with the bond requirements. In a few instances where bonds were not furnished and informal action failed, formal proceedings were instituted to effect compliance with the bond regulations.

TRADE PRACTICES

Supervisors continued their activities in assisting in the revision of tariffs and regulations of market agencies and stockyard companies and made numerous investigations and reports on general marketing conditions. A large number of complaints, both formal and informal, were received by the bureau and carefully investigated by either supervisors or special investigators in the field. In a great many instances the facts did not disclose any violations of the act. In some, certain unsatisfactory conditions which were found were corrected informally, and in others formal notices of inquiry were issued.

A number of trade-practice audits were made during the year at several markets, as a result of which certain unsatisfactory conditions and practices were corrected, usually through informal action. In some cases the conditions found were sufficiently serious to warrant formal proceedings, resulting in the suspension of the registrations of several market agencies and dealers.

On October 18, 1930, the Acting Secretary issued an inquiry and notice in Docket No. 330 alleging that about 45 market agencies and dealers registered and doing business at the St. Louis National Stockyards individually and in concert had engaged in and used unfair and unjustly discriminatory practices and devices and had conspired and agreed to boycott certain other agencies operating at the market. A hearing was held which commenced on November 6, 1930, and continued for several weeks. A large number of witnesses testified, the record in the case being voluminous. On December 19, 1930, oral argument was made before the Acting Secretary of Agriculture by counsel for all parties and on February 24, 1931, an order was issued requiring 42 respondents to cease and desist from boycotting other agencies and suspending the registrations of those respondents for a period of 90 days. The effective date of this order was postponed by subsequent orders to March 26, 1931, to afford the respondents an opportunity to file a petition with a statutory court of three judges in an effort to restrain the enforcement of the order. Details respecting this will be found in the discussion of cases in court arising under the act.

SCALES AND WEIGHING

During the year bureau weight supervisors visited practically all posted stockyards, where they made scale inspections, supervised tests, and checked weighing operations generally. The quarterly testing of livestock scales, introduced at several stockyards last year, has proved to be satisfactory, and the bureau has cooperated in this undertaking by having its weight supervisors present as often as practicable to supervise the tests.

AUDITS AND ACCOUNTS

During the year bureau accountants made financial audits of the books and records of 32 stockyard companies and 15 commission firms. Several of these audits were made for the purpose of determining the solvency of market agencies and resulted, in some cases, in the issuance of inquiries and the suspension of registrations

because of insolvency. Bureau accountants made trade-practice audits of the books and records of several market agencies and dealers located at various markets. Detailed audits were completed of the stockyard companies located at Omaha, Nebr., and National Stock Yards, Ill., preparatory to hearings in connection with the reasonableness of rates and charges for stockyard services. A similar audit was commenced at Sioux City, Iowa. In addition, the books and records of approximately 72 market agencies located at the St. Paul, Minn. and St. Joseph, Mo. stockyards were examined for the purpose of obtaining material for hearings in connection with the reasonableness of rates and charges for buying and selling livestock on commission.

Annual reports were received from all classes of agencies and persons subject to the provisions of the act. Information compiled from the reports received from packers, stockyard companies, and market agencies is shown in Tables 18 to 23, inclusive. The data compiled from traders' reports are shown in Table 23 and relate solely to those persons who were engaged strictly in a trading or speculative business. The various reports received cover business during the calendar year, with a few exceptions which are on the basis of the fiscal year. The tables afford a perspective of the volume and character of the business conducted by persons subject to the provisions of the act.

TABLE 18.—*Financial results of operations, during 1930, for 945 packers subject to the packers and stockyards act, grouped according to federally and non-federally inspected slaughtering and nonslaughtering concerns*

Group	Number of concerns	Average net worth ¹	Net sales	Net gain
Federally inspected slaughterers.....	220	\$826, 136, 541	\$3, 328, 001, 663	\$29, 135, 015
Nonfederally inspected slaughterers.....	466	60, 982, 602	299, 781, 760	3, 328, 310
Nonslaughterers ²	259	171, 821, 378	377, 734, 181	17, 532, 822
Total.....	945	1, 058, 940, 521	4, 005, 517, 604	49, 996, 147

¹ These figures represent the numerical average of the total net worth of reporting concerns at the beginning and end of their fiscal years.

² This group includes concerns which also handle commodities other than meat food products.

In addition to the complete reports from 945 packing concerns, financial details, lacking in some respects, were received from 52 other packers for the year 1930.

TABLE 19.—*Comparison of the operations of packers subject to the packers and stockyards act, 1926-1930*

Item	1926 (580 concerns)	1927 (611 concerns)	1928 (680 concerns)	1929 (832 concerns)	1930 (945 concerns)
Average net worth ¹	\$989, 916, 117	\$970, 772, 548	\$983, 705, 930	\$1, 019, 980, 098	\$1, 058, 940, 521
Total income.....	3, 758, 972, 700	3, 877, 621, 354	4, 110, 095, 060	4, 308, 814, 715	4, 023, 493, 741
Total expenses.....	3, 699, 943, 922	3, 839, 325, 046	4, 039, 890, 813	4, 243, 073, 083	3, 973, 497, 594
Net gain.....	59, 028, 778	38, 296, 308	70, 204, 247	65, 741, 632	49, 996, 147
Per cent of gain to net worth.....	5.96	3.94	7.14	6.45	4.72

¹ These figures represent the average of the total net worth of all reporting concerns at the beginning and end of their fiscal years.

STOCKYARDS POSTED UNDER THE PACKERS AND STOCKYARDS ACT

TABLE 20.—*Summary of consolidated balance sheets of 70 posted stockyards at close of year 1930*¹

Assets	Amount	Liabilities	Amount
Current.....	\$11,623,934	Current.....	\$2,425,687
Fixed.....	139,097,386	Other.....	39,228,299
Other.....	12,279,727	Capital and surplus.....	121,347,061
Total.....	163,001,047	Total.....	163,001,047

¹ 1 yard deposited. Reports from 1 yard not requested and 5 yards posted too late to submit figures for 1930 tabulation.

A summary of consolidated profit and loss statements of 70 posted stockyards for the year 1930¹ follows:

Income:

Yardage.....	\$11,510,210
Feed sales.....	10,948,589
Loading and unloading.....	1,588,482
Rent.....	2,138,085
Miscellaneous operations.....	3,411,290

Gross operating income.....	29,596,656
-----------------------------	------------

Expenses:

Salaries and wages.....	6,422,682
Cost of sales—feed.....	5,729,775
Depreciation.....	2,023,601
Taxes (excluding Federal income tax).....	1,530,242
Miscellaneous operating expenses.....	6,407,439

Total operating expenses.....	22,113,739
-------------------------------	------------

Net operating profit.....	7,482,917
---------------------------	-----------

Other income.....	1,050,073
-------------------	-----------

Deductions from income.....	8,532,990
	1,463,366

Net profit.....	7,069,624
-----------------	-----------

¹ 1 yard deposited. Reports from 1 yard not requested and 5 yards posted too late to submit figures for 1930 tabulation.

TABLE 21.—*Summary of reports from stockyard companies subject to the packers and stockyards act, 1926–1930*

Item	1926 (65 concerns)	1927 (69 concerns)	1928 (67 concerns)	1929 (69 concerns)	1930 (70 concerns)
Total average net worth.....	\$116,327,131	\$118,071,659	\$119,274,997	\$120,360,158	\$122,258,111
Gross income.....	36,086,366	35,108,893	31,355,620	30,157,389	30,646,729
Net gain.....	6,561,847	6,829,009	7,533,519	7,114,989	7,069,624
Per cent of gain to net worth.....	5.64	5.78	6.32	5.91	5.78

LIVESTOCK COMMISSION AGENCIES

Number and class of market agencies reporting in 1930 follows:

Old-line agencies.....	678
Cooperative agencies.....	35
Horse and mule agencies.....	14
Total.....	727

TABLE 22.—*Summary of consolidated operating statements of livestock commission agencies*

Item	1928 (752 agencies)	1929 (732 agencies)	1930 (727 agencies)
Total commissions earned.....	\$23,331,401	\$22,025,768	\$21,412,613
Total expenses (exclusive of owners' salaries).....	16,223,981	15,720,777	15,768,195
Net operating profit.....	7,107,420	6,304,991	5,644,418
Other income.....	1,126,666	1,066,828	900,784
Other expenses.....	38,589	41,301	23,586
Return to owners.....	8,195,497	7,330,518	6,521,616

TABLE 23.—*Summary of consolidated profit and loss statements of 853 traders on 36 markets for 1930¹*

Item	Dockage ²	Animals handled	Weight	Amount
Cattle:				
628 traders on 33 markets—	<i>Pounds</i>	<i>Number</i>	<i>Pounds</i>	<i>Dollars</i>
Selling data.....		3,275,264	1,772,699,608	160,461,234
Cost data.....		3,275,441	1,757,296,697	154,452,511
Sheep:				
63 traders on 19 markets—				
Selling data.....		1,307,402	76,442,014	6,881,826
Cost data.....		1,308,188	76,162,634	6,522,839
Horses and mules:				
12 traders on 2 markets—				
Selling data.....		34,958		4,089,243
Cost data.....		34,973		3,704,333
Hogs:				
204 traders on 31 markets—				
Selling data.....	3,516,581	3,178,379	684,996,815	65,722,465
Cost data.....	3,795,610	3,178,870	684,175,438	64,213,326
All species:				
853 traders on 36 markets—				
Selling price.....				237,154,768
Cost price.....				228,893,009
Gross trading profit.....				8,261,759
Clearance commissions received.....				20,208
Other income.....				248,824
Total earnings.....				8,530,791
Expenses:				
Salaries and wages (other than owners').....				1,507,648
Clearance commissions paid.....				553,732
Feed.....				2,030,147
Yardage.....				408,416
Other expenses.....				1,449,563
Total.....				5,949,506
Return to owners.....				2,581,285

¹ Does not include traders who were engaged also in order-buying business. Some of the traders handled more than one species.

² Represents deduction in weight at time of sale because of quality or condition of the animal. This practice applies only to hogs.

CONTROL OF INTERSTATE TRANSPORTATION OF LIVESTOCK

The bureau continued to exercise supervision over the interstate transportation of livestock for the purpose of preventing the spread of animal diseases. In the conduct of that work bureau employees inspected 18,322,587 cattle, of which 9,036 were dipped under supervision in order that they might continue in interstate commerce. Sheep to the number of 29,622,824 were also inspected for communicable diseases, and of these 406,381 were dipped under bureau supervision to comply with regulations of the department and the various States to which they were destined. Swine inspected numbered

37,472,904, of which 287,895 were immunized and disinfected against hog cholera under supervision in order that they might be distributed to country points for feeding and breeding purposes.

The bureau continued its cooperation with various transportation and marketing interests in an effort to reduce losses among stocker and feeder cattle on account of hemorrhagic septicemia. As in previous years the divisions of public stockyards in which that class of cattle is handled, and railroad stockyards, where livestock in transit are fed, watered, and rested, were again cleaned and disinfected under bureau supervision.

During the year 11,939 cars in which animals affected with communicable diseases were transported were received at bureau stations. Cars to the number of 22,394 were cleaned and disinfected under supervision in compliance with department regulations or on request of Canadian Government officials, State officials, and transportation companies.

The policy of having experienced veterinary inspectors at the various public stockyards give particular attention to the inspection of all ruminants and swine for foot-and-mouth disease was continued.

ENFORCEMENT OF TRANSPORTATION AND QUARANTINE LAWS

In its administration of the 28-hour law, which limits the time that animals may be confined in cars without feed, water, and rest, the bureau reported 257 apparent violations to the solicitor for presentation to the Attorney General. The penalties imposed in cases decided in favor of the Government amounted to \$22,800. The collection of evidence and the preparation of reports in these cases form a part of the regular duties of employees stationed at public stockyards. In addition, there are a few employees who devote their entire time to that work. As the result of inspections of feed, water, and rest yards and discussions with railroad officials, further improvements in facilities in such yards were effected at a few points.

In the administration of the animal quarantine laws and regulations, 41 cases of alleged violations were reported for prosecution during the year, and in the cases decided in favor of the Government fines imposed amounted to \$4,735. In addition, 4 cases involving imprisonment were for a total of 14 months.

PATHOLOGICAL DIVISION

Under the direction of John S. Buckley, chief, the Pathological Division has followed its usual line of scientific investigation of the diseases of domestic animals and birds, the poisoning of livestock by plants, and the examination of viruses, serums, and other biological products used in the treatment or prevention of diseases of domestic animals.

DIAGNOSIS AND CONTROL OF DISEASES

Cooperative work for the control and eradication of glanders in the various States was continued. The complement-fixation test was applied to 136 samples of blood serum from animals suspected of being affected with or exposed to the disease, 14 of which gave positive reactions.

In the course of the campaign for the control and eradication of dourine, 4,342 samples of blood serum from horses in districts where dourine is present or suspected were subjected to the complement-fixation test, and 61, or approximately 1.4 per cent, gave positive reactions.

Blood-serum samples from 24 horses, donkeys, and other animals offered for import were subjected to the complement-fixation test for glanders and trypanosomiasis before the animals were admitted.

Sixty-eight suspected cases of rabies were received and subjected to laboratory examination. Of these 56 were from dogs, 21 of which were positive. Of 4 cats, 3 cows, 1 hog, 1 squirrel, and 3 rats examined, no positive cases were found.

Autopsies were performed on 29 carcasses of animals which had died during the year at the National Zoological Park. An especially interesting case was that of a cat of the jaguar family, (*Felis jaguarondi*), in which hemorrhagic septicemia was found to be the cause of death.

During the year 1,280 poultry specimens were received for examination. Post-mortem and bacteriological examination revealed the usual affections common to poultry, including pullorum disease in baby chicks and adult birds, roup, chicken pox (diphtheria), infectious bronchitis, fowl cholera, fowl typhoid, tuberculosis, salpingitis, leukemia, pneumonia, tumors, and other abnormal conditions.

Investigational work with infectious bronchitis of adult fowls and a similar affection of baby chicks and quail was continued. Experimental studies of a chicken disease simulating fowl pest and New Castle disease revealed a filterable virus as the causative agent of the affection.

During the year 361 specimens were received for diagnosis from meat-inspection sources, and 140 specimens of various species of animals from other sources. These specimens are not included in the number of specimens mentioned elsewhere in this report.

Investigations into the cause of peculiar tuberculosislike lesions in the bones of the spinal column of hogs slaughtered at a number of stations under Federal inspection were continued. It was definitely shown that *Brucella abortus* (porcine type) is the causative agent of the condition. Positive findings were obtained in 22 specimens received from the following stations: Mason City, Iowa; Sioux Falls, S. Dak.; and South St. Joseph, Mo.

RESEARCH ON DISEASES

A test on the duration of the immunity produced by a single dose of prophylactic vaccine in dogs was completed during the year. Of 5 dogs given a single dose of vaccine, 4 were found resistant after 14 months to a dose of rabies street virus sufficiently active to produce rabies in 4 of 5 control dogs.

Six cases of acute swine erysipelas were diagnosed from February to May, 1931, in addition to others received in recent years. The six cases were from South Dakota, where the disease appears to exist in the southern part of the State. The swine-erysipelas organism was isolated frequently in pure culture from the blood, lung, liver, spleen, kidney, and various lymph glands.

In connection with these studies there was produced in a pig a hyperimmune serum which was found to have a very high titer when used in agglutination tests against an antigen consisting of concentrated swine-erysipelas organisms grown in bouillon.

Pathological and bacteriological studies of the so-called "lunger" sheep disease of Montana have been continued. Several types of microorganisms have been recovered from the lungs of affected sheep, but none has been definitely incriminated, by actual inoculation experiments, as the causative factor. Likewise material from diseased lungs has thus far given negative results in all animal-inoculation tests.

Further studies of nasal granuloma as it occurs among the cattle of the Iberia Livestock Experiment Farm, Jeanerette, La., were made during the year. Bacteriological findings and animal-inoculation experiments have not yet disclosed the identity of the causative agent. A paper reporting the results of this investigation is being prepared for publication.

A hog which had reacted to the tuberculin test had at autopsy slight lesions of tuberculosis confined to a few lymph nodes. Specimens of the affected glands were examined bacteriologically, and tubercle bacilli were isolated which were positively identified as belonging to the human type.

Investigation of cancer of the eye in cattle, a disease which appears to be on the increase in southwestern United States, was continued. By means of differential nuclear stains, attempts have been made to compare malignancy with rapidity of growth. Animal-inoculation tests of filtrates prepared from fresh specimens have thus far given negative results.

Experimental animals, inoculated with blood from animals in the Mississippi Delta and Nevada, suspected of being affected with swamp fever, were the subject of clinical and laboratory study. No evidence of anemia was found in any of the animals reacting after inoculations. A number of samples of serum were tested by the mercuric chloride diagnostic test for swamp fever, and the results obtained indicated the necessity of further refinements of the test before it can be of practical value.

In cooperation with the Bureau of Biological Survey, the Pathological Division made a study of areas in Oregon and northern California where outbreaks of the so-called duck sickness occur. The results indicated that there was no correlation between the amount of alkali present in the waters of the lakes and the presence of duck sickness. Bacteriological study of mud from Tule Lake, Calif., where duck sickness was prevalent, and of the organs of affected ducks revealed the presence of *Clostridium botulinum* type C. The toxin produced by that organism, when fed to domestic mallard ducks in small doses, produced symptoms of botulism which were typical of those of duck sickness.

Anaplasmosis studies were continued at the Washington laboratory and at the bureau's Experiment Station at Bethesda, Md. In this work use has been made of the operation known as splenectomy, by which one removes the major part of the reticulo-endothelial

system thereby rendering the organism highly susceptible to infection by anaplasmas. Rapidly fatal cases of the disease have been produced in splenectomized cattle with blood from animals that have remained carriers for nearly four years. Of three cattle which had recovered from the disease early in the fall of 1927, two were shown by blood-inoculation tests in normal splenectomized cattle to be carriers of the infection nearly four years later. A 6-months-old calf inoculated with anaplasmosis blood from Kansas failed to develop any symptoms of the disease but, following splenectomy more than a year later, the latent infection was awakened and a very severe form of the disease ensued, with nearly 70 per cent of the red blood cells parasitized. It has been found that the infected blood of the splenectomized subject is of much value in serological studies which are now being made.

A Kansas strain of anaplasma was shown, by blood-inoculation tests, to be identical with a Florida strain. A calf born of a carrier cow was found to be fully susceptible to the disease when tested at the age of about 1½ years.

In Florida, anaplasmosis was diagnosed in three range cattle from the central part of the State. In 13 herds which were injected with incubation-virus vaccine during the winter of 1927-28, no cases of anaplasmosis have developed.

Other phases of anaplasmosis investigations are discussed in the report of work by the pathological laboratory at Denver, and by the Zoological Division.

TESTING BIOLOGICAL PRODUCTS

Cooperating with the Division of Virus-Serum Control in the enforcement of the virus-serum-toxin act, the Pathological Division was called on to examine biological products and cultures prepared under United States veterinary licenses.

During the year 67 representative samples of serums, vaccines, bacterins, and antitoxins were examined for purity, potency, and safety. Of these 58 were approved, and 9 were disapproved. In the same period 46 cultures were tested, of which 17 were found to be unsatisfactory for their intended purpose.

INVESTIGATION OF STOCK-POISONING PLANTS

Investigations of plants suspected to be poisonous to livestock were continued during the year on the same plan as heretofore. Most of the experimental work was carried on at the Salina Experiment Station, near Salina, Utah. Feeding experiments were undertaken with 27 plants suspected of causing losses in livestock. A series of feeding experiments was conducted with bitter weed (*Actinea odorata*) which occurs in great abundance in western Texas where there have been severe losses among sheep in recent years. The toxic character of the plant was determined, and considerable information was obtained regarding conditions under which the poisoning of sheep occurs, the quantity of the plant necessary to cause illness and death, and the symptoms produced.

Loco investigations were continued as a cooperative project between the bureau and the Texas Agricultural and Mechanical College. The results obtained from feeding experiments with one species (*Astragalus earlei*) indicated that horses, cattle, sheep, and goats may be poisoned by consuming this plant. Horses appear to be more susceptible to the poison than other stock. The disease produced is characterized by an involvement of the nervous system with symptoms of muscular incoordination. Experiments carried on with another species of loco (*A. wootoni*) though not yet completed, tend to show that this species causes a type of poisoning similar to that produced by *A. earlei*.

TOXICOLOGICAL INVESTIGATIONS

Studies to isolate the toxic principle of *Actinea odorata* (bitterweed) were begun. Several extracts were made and fed to rats without definite results. The work is being continued.

Chemical study of yellow livers of cattle has been continued. A quantity of a substance has been isolated that crystallizes in needles and appears to be the toxic substance responsible for the disease.

Chemical studies of the alkaloids from *Lupinus palmeri*, *L. argenteus*, *L. cruckshanksii*, *L. foliosus*, and *L. laxiflorus-silvicola* have been continued. A method has been developed whereby hitherto unknown alkaloids in the lupines may be isolated in pure condition and studied exactly. Material of *L. rivularis*, *L. sericeus*, and *L. andersoni* was collected for chemical study.

Work on the emetic principle of scabby barley has been continued. The substance has been isolated in fairly pure condition but has not yet been obtained crystalline.

Work on Daubentonia has been continued. The active principle has been isolated in crude form, and the problem now is to purify it for exact chemical study.

BRANCH LABORATORIES

BETHESDA, MD.

The poultry pathology laboratory at Bethesda, Md., pursued studies in the serological diagnosis of pullorum disease, consisting in the comparison of the rapid, whole-blood method and the slow method of agglutination testing, and a comparison of the results of both tests with bacteriological findings at autopsy of reacting and nonreacting fowls. All rapid whole-blood agglutination tests were carried out with stained antigens supplied by the Biochemic Division.

More than 10,000 tests were made, including fowls, at the following places in or near Washington, D. C.: United States Soldiers' Home, Government Hospital for the Insane, United States Animal Husbandry Experiment Farm, Experiment Station at Bethesda, and six commercial poultry flocks in Montgomery County, Md. As a result of these field tests, a flock of reacting and nonreacting fowls was assembled for further study.

The testing of 206 hens by the tube agglutination test and the rapid, whole-blood agglutination test for pullorum disease showed an agreement of 91 per cent between the two tests.

Of the reactors to the tube test, 80 per cent at autopsy yielded *Salmonella pullorum* from their ovaries. Of the reactors to the rapid, whole-blood test 83 per cent at autopsy yielded *S. pullorum* from their ovaries.

Of the infected reactors, 75.4 per cent had active ovaries, and 24.6 per cent had inactive ovaries at time of slaughter.

Of the infected ovaries, 11.4 per cent showed no gross pathological lesions. Of all reactors autopsied, 10 per cent failed to show gross lesions or the presence of *S. pullorum* in their ovaries, whereas 2.7 per cent had gross pathological lesions but did not yield *S. pullorum* in their ovaries.

In a cooperative experiment with the Animal Husbandry Division and a local institution in which hatchings were made of a large number of eggs from reactor birds, all the chicks that died were examined bacteriologically but in no instance was any evidence of *S. pullorum* found. In a few cases an organism indistinguishable from *Bacillus paratyphosus A* was isolated and found to be agglutinated with pullorum serum. Further studies regarding the possibility of this organism being a complicating factor in pullorum-disease testing are being made.

CHICAGO

The branch pathological laboratory at Chicago, Ill., continued the investigations of diseases of meat food animals as they are encountered in animals slaughtered in establishments operating under Federal meat inspection. Cooperating with the Federal Food and Drug Administration laboratory at Chicago, Ill., the Chicago laboratory examined several hundred cold-storage chickens. Tuberculosis was the predominant disease found; other affections included leukemia, enteritis, peritonitis, and pyemia. Some of the poultry were in various stages of putrid decomposition.

Cooperation and assistance were extended to the laboratories of the Chicago Health Department and the Municipal Tuberculosis Sanitarium, as well as to medical colleges.

During the year several field investigations were conducted in which anthrax was found in swine. The districts affected were in the Central West, principally in the upper Missouri River Valley.

The pathological laboratories at Omaha, Nebr., were discontinued during the year, and most of the work formerly conducted there was diverted to the Chicago laboratory.

DENVER

During the year 2,966 specimens were received at the Denver laboratory for examination. A considerable part of the material consisted of blood samples for the agglutination test for abortion disease and chicks for diagnosis of pullorum infection.

The major project during the year was the investigation of anaplasmosis in cooperation with the Oklahoma Agricultural and

Mechanical College. The results of transmission experiments point to flies (Tabanids) as possible carriers of the disease.

Miscellaneous work included studies of a condition in rabbits known as bloat and tuberculosis in pigeons.

TICK-ERADICATION DIVISION

The work of freeing the South from the cattle tick which transmits splenetic, southern, or tick fever in cattle was continued under the direction of R. A. Ramsay, chief, in cooperation with cattle owners and State and county officials in the infested Southern States.

The reduction that the systematic campaign of eradication has made in the size of the tick-infested area, with the corresponding reduction in the need for bureau supervision and control work, has in recent years permitted greater centralization of effort in the remaining infested territory. This reduction also has made it possible for the bureau to increase the amount of Federal aid given these areas and at the same time increase the protection to the free areas.

The number of local cattle inspectors or agents employed by the bureau during the year was the largest in the history of the work and prevented a slowing up of the work in several sections where, because of the depression and drought conditions, the local appropriation for tick eradication was inadequate.

At the close of the fiscal year 461 veterinarians and other bureau employees, engaged in this project, were working in cooperation with 348 State and 65 county employees. Under the supervision of these cooperative forces 14,958,050 inspections or dippings of cattle and 1,175,486 inspections or dippings of horses and mules were conducted. More than 13,000 vats were used in the official dippings.

RESULTS FOLLOWING THE YEAR'S ACTIVITIES

The following areas were released from Federal quarantine as a result of tick-eradication activities: Four counties and the remainder of 1 county in Arkansas, 5 counties and part of 1 county in Florida, 17 counties in Mississippi, and 9 counties and the remainder of 2 counties and part of 1 county in Texas. The aggregate area of this territory was 24,956 square miles. The release of territory in Mississippi frees all of that State from Federal quarantine, making it the eleventh of the original 15 tick-infested States to reach that goal.

The close of the year found the Federal quarantine for cattle-tick infestation in the United States limited to parts of four States, namely, Arkansas, Louisiana, Florida, and Texas. In Arkansas the work, after being retarded for two years by insufficient funds, has received the stimulus of an adequate State appropriation and is again making very satisfactory progress. In Florida and Texas the vigorous eradication campaign continues to make substantial additions to the tick-free territory in each State. In Louisiana, owing to the failure of that State to provide funds for the work, it was impractical to extend tick eradication, and no effort was made to conduct systematic work in the quarantined area of the State. Table 24 shows the progress made in tick eradication since its beginning in 1906 and gives the status of the work at the close of the fiscal year 1931.

TABLE 24.—*Tick-eradication results July 1, 1906, to June 30, 1931*

State	Counties quarantined on—		Counties released to June 30, 1931	Released counties tick free on Nov. 1—				
	July 1, 1906	June 30, 1931		1926	1927	1928	1929	1930
Alabama.....	67	0	67	49	57	59	63	64
Arkansas.....	75	15	60	41	44	45	45	53
California.....	15	0	15	15	15	15	15	15
Florida.....	67	32	35	12	14	22	30	33
Georgia.....	158	0	158	151	153	154	155	158
Kentucky.....	2	0	2	2	2	2	2	2
Louisiana.....	64	42	22	11	4	8	3	10
Mississippi.....	82	0	82	47	46	45	55	78
Missouri.....	4	0	4	4	4	4	4	4
North Carolina.....	73	0	73	73	71	73	73	70
Oklahoma.....	61	0	61	55	54	54	60	61
South Carolina.....	46	0	46	40	44	46	46	46
Tennessee.....	42	0	42	42	42	42	42	42
Texas.....	198	57	141	72	77	79	94	116
Virginia.....	31	0	31	27	26	29	30	31
Total.....	985	146	839	641	653	677	717	783

MOVEMENTS FROM QUARANTINED AREAS

In the enforcement of department regulations governing the interstate movement of cattle and horses from the areas quarantined for splenic, southern, or tick fever, 138,010 cattle were inspected, or dipped and inspected, for which 2,584 certificates were issued authorizing their interstate movement as noninfectious. Horses and mules to the number of 4,971 were also inspected in the quarantined areas and 489 certificates issued authorizing their movement from the area.

MOTION PICTURES

The use of motion pictures in illustrating the methods used in eradicating ticks and the benefits to be derived from this work was continued as a preliminary step in each county in which systematic work was undertaken. During the year two portable motion-picture outfits were used to give 371 exhibitions in Arkansas, Florida, and Texas with a total attendance of 51,854 persons.

TUBERCULOSIS ERADICATION DIVISION

The work of tuberculosis eradication in cooperation with the various States, counties, and livestock owners made substantial progress during the year. This work on the part of the bureau was directed by A. E. Wight, chief of the Tuberculosis Eradication Division.

The year's activities consisted largely in the tuberculin testing of cattle under the area plan. Altogether 13,782,273 cattle were tested, or about 936,000 more than in any preceding year. The percentage of reactors dropped from 1.7 for the fiscal year 1930 to 1.5 per cent. This decrease indicates continued progress in eradicating the disease.

The bureau's force engaged in tuberculosis eradication averaged 195 veterinarians, who were under the supervision of inspectors in charge of 44 field stations. The respective States had under the jurisdiction of their livestock officials an average of 408 veterinarians, a small number of whom were employed by municipalities. In addition, counties cooperating with the officials of the States and the bureau employed an average of 311 veterinary inspectors on full time. Thus, there were 914 veterinarians engaged in the work regu-

larly throughout the year, which is a decrease of approximately 34 full-time employees as compared with the preceding year.

The Federal appropriation for the work was \$6,190,000, of which \$1,190,000 was allotted for operating expenses and \$5,000,000 for paying indemnity to owners for cattle condemned as a result of the test. The combined State and county appropriations amounted to more than \$13,500,000.

The plans for the work now include (1) the eradication of tuberculosis under the accredited-herd plan, (2) eradication under the area plan, (3) eradication of tuberculosis from swine, (4) investigations relative to interstate shipments, (5) tuberculosis in fowls, and (6) the control and eradication of Johne's disease (paratuberculosis).

The retesting of cattle in modified accredited areas has resulted in conclusive evidence that bovine tuberculosis can be kept at a minimum provided attention is given to the necessary sanitary measures.

The tuberculin testing of all the cattle in Indiana was completed during the year, and the entire State was declared a "modified accredited area" on July 1, 1931, signifying that tuberculosis among the cattle in that State does not exceed one-half of 1 per cent. Indiana is the fourth State so classified, the others being North Carolina, Maine, and Michigan.

Several important cases were taken up in the courts of various parts of the country during the year to determine the constitutionality of the laws requiring cattle to be tuberculin tested, with results upholding the statutes in every instance. One case that had been in several courts in Iowa was finally taken to the United States Supreme Court upon an appeal from the State Supreme Court. The result was in favor of the State, as it was determined that the United States Supreme Court was without jurisdiction in the matter. That mandate automatically dissolved local injunctions temporarily suspending the work in 11 Iowa counties. It was a most important step toward the continuance and completion of this project in the State of Iowa.

Favorable action toward continuing tuberculosis-eradication work among livestock was taken in all States where the legislatures met. In some of the Eastern States very large appropriations were made for the work to meet the increased demands for it in sections where tuberculosis in cattle is very prevalent. Provision was made by the California Legislature for the payment of indemnity for condemned tuberculous cattle in that State.

Results of tests of cattle with johnin or avian tuberculin for the detection of paratuberculosis showed the disease to exist in a slight degree in 12 States. Altogether 192 cattle were condemned on account of the disease, this number being approximately 5 per cent of the total number examined.

PROGRESS IN TUBERCULIN TESTING OF CATTLE

The total numbers of herds and cattle under supervision at the end of the year were 3,276,419 and 30,033,156, respectively. It is also noteworthy that 23 States reported that more than 50 per cent of their cattle are under supervision for the eradication of tuberculosis. As an indication of the continued interest in the work throughout the United States, there was at the end of the year a waiting list of more than 2,383,497 cattle.

Marked increase in the herds under supervision as the result of accredited-herd work and area work resulted in the tuberculin testing of 1,162,414 herds, including 13,782,273 cattle. These figures include cattle tested for interstate shipment. The testing resulted in the removal of 203,778 reactors, or 1.5 per cent, which is the smallest percentage since the beginning of the work. It is noteworthy, as shown in Table 25, that since 1917 reactors to the number of 2,183,689 have been removed from the cattle herds of the Nation. This has been done without serious economic disturbance or creating any shortage of the necessary milk supply.

TABLE 25.—*Progress of tuberculin testing under accredited-herd and area plans, 1917-1931*

Year ended June 30	Cattle tested					Modified accredited counties	Herds accredited ¹	Herds passed ¹ test ¹	Herds under supervision ¹
	Accredited-herd plan	Area plan	Total	Reactors found	Per cent of reactors				
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>		<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
1917.....	20, 101		20, 101	645	3.2			883	
1918.....	134, 143		134, 143	6, 544	4.9		204	883	
1919.....	329, 878		329, 878	13, 528	4.1		578	5, 652	
1920.....	700, 670		700, 670	28, 709	4.1		2, 588	10, 064	
1921.....	1, 366, 358		1, 366, 358	53, 768	3.9		4, 831	33, 215	71, 806
1922.....	1, 722, 209	² 662, 027	2, 384, 236	82, 569	3.5		8, 015	111, 719	140, 376
1923.....	1, 695, 662	1, 765, 187	3, 460, 849	113, 844	3.3		12, 310	150, 748	187, 915
1924.....	1, 865, 863	3, 446, 501	5, 312, 364	171, 559	3.2	38	19, 747	216, 737	305, 809
1925.....	2, 008, 526	4, 991, 502	7, 000, 028	214, 491	3.1	51	24, 110	392, 740	414, 620
1926.....	1, 989, 048	6, 661, 732	8, 650, 780	323, 084	3.7	109	24, 009	382, 674	435, 840
1927.....	2, 522, 791	7, 177, 385	9, 700, 176	285, 361	2.9	149	34, 084	229, 086	261, 148
1928.....	2, 589, 844	8, 691, 646	11, 281, 490	262, 113	2.3	180	38, 880	427, 595	473, 218
1929.....	2, 853, 633	8, 830, 087	11, 683, 720	206, 764	1.8	213	1, 639	249, 420	281, 323
1930.....	2, 953, 350	9, 892, 521	12, 845, 871	216, 932	1.7	236	11, 863	227, 921	347, 448
1931.....	3, 086, 403	10, 695, 870	13, 782, 273	203, 778	1.5	247	⁴ -26, 259	350, 735	356, 916
Total.....	25, 838, 479	62, 814, 458	88, 652, 937	2, 183, 689	2.5	³ 1, 223	156, 599	2, 789, 189	3, 276, 419

¹ The figures in these columns represent net increases at the close of each year.

² Testing during 6 months.

³ Not including parts of 2 counties and 50 towns.

⁴ Represents decrease over figures for previous year.

Of the cattle reported as tested (Table 25), about 16 per cent were tested by bureau inspectors and about 84 per cent by State, county, municipal, and accredited practicing veterinarians. Constant efforts were made through field supervision to maintain the tuberculin test at its highest possible efficiency. With an average of 914 veterinarians engaged daily in the work, it can be seen that this was necessary in order that the high standards established in the past might be maintained. The standard of professional service rendered during the year is considered to have been of a high degree of excellence. Attention was given also to so-called no-visible-lesion cases noted on post-mortem examination of slaughtered reacting cattle. More than half of such cases were found to have originated in herds known to harbor infection.

ERADICATION OF TUBERCULOSIS FROM AREAS

The area work has continued to grow, indicating both the efficiency and popularity of this plan. Approximately 78 per cent of all the cattle tested in the work of eradication were tested under the area plan.

At the conclusion of the year 1,577 counties and the District of Columbia had engaged in area work. This is an increase of 164 counties, or approximately 12 per cent, over the number for the preceding year. County expenditures for the furtherance of area work were approximately \$1,300,000.

At the conclusion of the year the modified accredited area included 1,223 counties, 50 towns, and parts of 2 other counties. This is in comparison with 976 counties, 43 towns, and parts of 3 other counties at the end of the fiscal year 1930. Field reports indicate that at the end of the present fiscal year 39.8 per cent of the total counties in the United States were modified accredited areas, and that, including the modified counties, 51.3 per cent of the entire number of counties in the United States were engaged in eradicating the disease from their livestock. Table 26 shows the status of area work on June 30, 1931.

TABLE 26.—*Status of tuberculosis eradication from county areas at close of fiscal year, 1931*

State	Total counties in State ¹	Counties completing one or more tests of all cattle ¹	Counties intensively engaged in testing	Total counties engaged ¹	Modified accredited areas ¹
Alabama.....	67	8	1	9	8
Arizona.....	14	0	2	2	0
Arkansas.....	75	3	1	4	3
California.....	58	7	2	9	6
Colorado.....	63	0	2	2	0
Connecticut.....	8	0	4	4	0
Delaware.....	3	1	0	1	1
District of Columbia.....	1	1	0	1	1
Florida.....	67	4	0	4	1
Georgia.....	161	42	4	46	40
Idaho.....	44	39	5	44	39
Illinois.....	102	77	25	102	76
Indiana.....	92	92	0	92	92
Iowa.....	99	68	31	99	63
Kansas.....	105	54	4	58	54
Kentucky.....	120	70	9	79	03
Louisiana.....	64	0	0	0	6
Maine.....	16	16	0	16	16
Maryland.....	23	9	8	17	2
Massachusetts.....	14	1	2	3	1
Michigan.....	83	83	0	83	83
Minnesota.....	87	57	0	57	56
Mississippi.....	82	9	0	9	8
Missouri.....	114	17	11	28	17
Montana.....	56	² 15	(²)	16	² 15
Nebraska.....	93	48	4	52	46
Nevada.....	17	8	7	15	8
New Hampshire.....	10	3	3	6	3
New Jersey.....	21	0	0	0	0
New Mexico.....	31	0	20	20	0
New York.....	62	26	31	57	12
North Carolina.....	100	100	0	100	100
North Dakota.....	53	45	5	50	45
Ohio.....	88	84	1	85	82
Oklahoma.....	77	3	1	4	2
Oregon.....	36	16	17	33	10
Pennsylvania.....	67	39	22	61	39
Rhode Island.....	5	0	0	0	0
South Carolina.....	46	23	3	26	23
South Dakota.....	69	6	0	6	6
Tennessee.....	95	21	0	21	21
Texas.....	254	3	1	4	3
Utah.....	29	6	22	28	6
Vermont.....	14	(³)	10	10	(³)
Virginia.....	100	50	17	67	50
Washington.....	39	² 30	² 7	38	² 26
West Virginia.....	55	32	7	39	32
Wisconsin.....	71	71	0	71	64
Wyoming.....	23	0	0	0	0
Total.....	3, 073	1, 287	289	1, 578	⁴ 1, 223

¹ Including District of Columbia.

² Not including part of 1 county.

³ Not including 50 towns.

⁴ Not including part of 2 counties and 50 towns.

CHANGE IN THE UNIFORM AREA PLAN

At the meeting of the United States Livestock Sanitary Association, held in Chicago, Ill., December 4, 1930, a modification of the area plan was adopted. This provision makes it possible to exempt a large percentage of range cattle from the tuberculin test if no infection is found among the ones that can be conveniently tested on the same ranch. This amendment was promptly approved by the bureau and put into operation in several Western States. As an indication of the practicability and value of the plan, since it took effect 22 counties included in such States have been declared modified accredited areas.

STATISTICS OF SLAUGHTER AND INDEMNITY

There was a marked decrease in the average amount received as salvage for condemned tuberculous cattle, owing to lower beef prices. Appraisals also were considerably reduced. Salvage and appraisal values for the fiscal year 1931 are given in Table 27. State and bureau officials engaged in tuberculosis-eradication work have continued to assist in having the best possible prices paid for reactors.

B. A. I. Order 329, effective July 1, 1931, provides that the maximum Federal payment shall be \$25 for grade cattle and \$50 for purebred registered cattle as compared with the former maximum amounts of \$35 and \$70, respectively.

TABLE 27.—*Cattle slaughtered, appraised value, indemnity allowed, and salvage realized in work of tuberculosis eradication, fiscal year 1931*

State or Territory	Cattle slaughtered	Average appraisal per head	Indemnity		Average indemnity per head		Average salvage per head
			State	Federal	State	Federal	
	<i>Number</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Alaska.....	16	207.81	1,656.62	591.66	103.54	36.98	0.00
Arizona.....	514	128.79	13,285.45	13,285.45	25.85	25.85	21.19
Colorado.....	58	98.02	1,257.58	1,243.55	21.68	21.44	26.38
Connecticut.....	4,066	102.88	210,864.67	102,975.30	51.86	25.33	25.57
Delaware.....	1,384	102.14	56,130.23	37,052.60	40.56	26.77	21.43
Florida.....	246	54.86	6,118.25	3,063.42	24.87	12.45	17.42
Georgia.....	52	71.90	1,061.42	1,061.42	20.41	20.41	11.71
Hawaii.....	152	182.63	13,440.00	3,973.47	88.42	26.14	52.37
Idaho.....	104	81.13	2,431.09	2,431.09	23.38	23.38	11.31
Illinois.....	18,124	107.10	452,890.82	452,890.82	24.99	24.99	30.52
Indiana.....	1,162	92.47	26,180.33	25,711.94	22.53	22.13	24.47
Iowa.....	19,043	103.32	476,410.58	465,096.40	25.02	24.42	28.37
Kansas.....	933	81.10	15,852.88	15,824.03	16.99	16.96	22.21
Kentucky.....	240	75.23	9,190.66	4,358.01	38.29	18.16	16.70
Louisiana.....	846	71.76	16,764.90	16,621.78	19.82	19.65	14.04
Maine ¹	188	78.69	10,786.13	3,709.31	57.37	19.73	18.93
Maryland.....	3,894	106.70	112,395.21	112,395.21	28.86	28.86	21.00
Massachusetts.....	11,649	130.18	541,339.93	379,278.37	46.49	32.56	24.25
Michigan.....	1,683	110.84	57,397.41	45,216.63	34.10	26.87	23.34
Minnesota.....	8,418	88.44	187,141.03	168,087.30	22.23	19.97	26.51
Mississippi.....	8	47.13	98.65	98.65	12.33	12.33	.00
Missouri.....	361	93.39	7,306.34	7,306.34	20.24	20.24	23.51
Montana ¹	172	42.96	4,825.43	1,869.65	28.05	10.87	19.54
Nebraska.....	2,924	93.50	60,159.15	59,792.81	20.57	20.45	27.08
Nevada.....	42	51.07	603.93	576.84	14.38	13.73	12.35
New Hampshire.....	2,205	79.84	85,373.62	47,129.17	38.72	21.37	15.95
New Jersey.....	7,574	116.63	433,860.42	224,113.63	37.28	29.69	22.63
New Mexico.....	64	85.55	1,591.58	1,591.58	24.87	24.87	7.84
New York.....	26,564	114.70	1,791,165.87	637,691.09	67.43	24.01	22.22
North Carolina.....	40	113.25	1,097.44	1,097.44	27.44	27.44	15.81
North Dakota.....	1,383	65.98	20,314.27	20,314.27	14.69	14.69	21.96
Ohio.....	4,412	132.17	144,502.34	141,378.07	32.75	32.04	29.00

¹ Salvage paid to State.

TABLE 27.—*Cattle slaughtered, appraised value, indemnity allowed, and salvage realized in work of tuberculosis eradication, fiscal year 1931—Continued*

State or Territory	Cattle slaugh- tered	Average appraisal per head	Indemnity		Average indemnity per head		Average salvage per head
			State	Federal	State	Federal	
	<i>Number</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Oklahoma.....	181	80.68	4,411.93	3,656.68	24.38	20.20	17.28
Oregon.....	316	103.13	5,032.61	5,032.61	15.93	15.93	23.40
Pennsylvania.....	23,549	134.10	951,118.05	775,031.21	40.39	32.91	25.07
Rhode Island.....	1,159	136.82	62,486.67	39,388.68	53.91	33.99	28.43
South Carolina.....	37	68.11	757.58	757.58	20.48	20.48	8.91
South Dakota.....	1,513	78.80	25,438.30	25,433.09	16.81	16.81	27.85
Tennessee.....	157	70.07	2,900.33	2,816.48	18.47	17.94	14.50
Texas.....	636	117.31	19,544.84	19,439.64	30.73	30.57	18.58
Utah.....	605	100.45	15,602.21	15,601.99	25.79	25.79	22.21
Vermont.....	5,204	84.58	128,220.70	128,220.70	24.64	24.64	11.84
Virginia.....	785	98.34	17,576.53	17,574.86	22.39	22.39	20.29
Washington.....	1,767	115.76	44,813.25	44,803.05	25.36	25.36	26.08
West Virginia.....	277	82.64	8,939.58	4,558.22	32.27	16.46	17.26
Wisconsin.....	5,725	111.67	146,553.71	146,533.71	25.60	25.60	31.07
Wyoming.....	36	100.69	547.32	547.27	15.20	15.20	10.84
Total.....	160,468	111.32	6,197,637.84	4,227,243.07	38.62	26.34	24.96

REGULATION OF INTERSTATE MOVEMENT OF CATTLE

Under the provisions of regulation 7, B. A. I. Order 309, the approved veterinary practitioners throughout the 48 States continue to conduct most of the tuberculin testing for interstate shipments of cattle. There were on the list of approved veterinarians on June 30, 1931, more than 9,900 veterinary practitioners, who, under a cooperative plan, are approved by the State and Federal livestock sanitary officials. These men tested for interstate shipment 21,137 lots containing 221,105 cattle, of which 0.2 per cent reacted. The number tested is a decrease of 117,507 cattle from that reported during 1930.

In an effort to assist livestock owners in facilitating the interstate movement of cattle, bureau inspectors tested, under the provisions of the regulations at public stockyards, 28,543 cattle, of which 0.5 per cent reacted. These figures of testing by bureau and approved veterinarians are included in the total testing for the year as reported in Table 25. Interstate transportation of reactor cattle, also under the provisions of regulation 7, for the purpose of immediate slaughter, was continued under the permit system. Permits were issued covering the movement of 37,173 such cattle.

ERADICATION OF TUBERCULOSIS FROM SWINE

Increased efforts have been made to trace the sources of infection in swine affected with tuberculosis. This has resulted in finding tuberculous fowls responsible for a large majority of the slight cases of tuberculosis found in swine. It has also been responsible for the elimination of many local foci of infection.

ERADICATION OF TUBERCULOSIS FROM POULTRY

Tuberculosis-eradication work in poultry included giving poultry owners information on the need of proper sanitation, maintenance of flocks under the best conditions of poultry husbandry, and the use of the tuberculin test when necessary for the diagnosis of the disease.

The survey of farm poultry flocks in connection with the testing of cattle, begun several years ago, was continued. During the year 186,966 flocks, containing approximately 21,174,707 fowls, in 25 States, were inspected. Of these, 9,347 were found to be infected with tuberculosis, as indicated by cases of the disease in the flocks. These inspections were made by veterinarians engaged in the testing of cattle and with very little additional cost to the department.

A provision in the agricultural appropriation act for the fiscal year 1932 makes it possible to extend this activity in accordance with plans now being formulated. This branch of the work is being confined largely to the mid-Western and North Central States, where the disease is most prevalent.

CONFERENCES AND PUBLICITY ON TUBERCULOSIS ERADICATION

The Southwestern States Tuberculosis Eradication Conference was held at Jackson, Miss., January 21 and 22, 1931, and the mid-Western States Conference was held at St. Paul, Minn., June 11 and 12. A local conference covering the New England States, New York, and New Jersey, was held at Burlington, Vt., June 18, attendance being limited to those directing the work. What was termed an "achievement" tuberculosis conference was held at Lansing, Mich., September 19, 1930. This was very well attended by officials and cattle owners, who were appreciative of the fact that so much had been accomplished in eradicating bovine tuberculosis in that State. Plans for the development of avian-tuberculosis work were also discussed.

Two new posters pertaining to the control and eradication of avian tuberculosis in poultry and swine were prepared and distributed.

DIVISION OF VIRUS-SERUM CONTROL

The activities of the Division of Virus-Serum Control, directed by D. I. Skidmore, chief, involved the administrative and regulatory work authorized by the virus-serum toxin act of 1913. This work, as before, consisted chiefly in the issuance of licenses to establishments producing veterinary biological products intended for sale in interstate commerce, the inspection of sanitary conditions of producing laboratories and methods of production and testing of biologics, and the certification of products for export. It also includes the issuance of permits to import biologics from abroad, together with the inspection of shipments of such biologics at ports of entry.

WORK AT LICENSED ESTABLISHMENTS

At the close of the year supervision was exercised over 82 licensed establishments as compared with 84 last year. The establishments were distributed among 59 cities and towns in 20 States. At the close of the year 46 establishments were engaged in producing only anti-hog-cholera serum and hog-cholera virus, 31 were producing other biologics only, and 5 were producing both classes of products. Inspectors of the bureau, as heretofore, supervised the production and testing of anti-hog-cholera serum and hog-cholera virus and also conducted tests to determine whether these products were properly preserved. They also made periodical visits of inspection to establishments producing other biologics. Samples of biologics, as well

as cultures of organisms used in their production, were collected for examination at the time of many of these visits.

In order to carry out the work it was necessary to maintain an average of 93 inspectors in the field. These inspectors examined and admitted to licensed establishments 386,740 hogs and 878 calves. Of these, 91 hogs were rejected at the time they were offered for admission and 21,831 hogs were rejected after admission because of conditions which made them unsuitable for the production or testing of biologics. The inspectors also collected samples from 3,373 batches of anti-hog-cholera serum and from 3,334 batches of simultaneous virus. There were supervised 4,205 potency and 3,415 purity tests of anti-hog-cholera serum and 3,354 purity tests of simultaneous virus.

Of 305 samples collected by field inspectors of the division for laboratory examination, 252 were satisfactory and 53 unsatisfactory. Of 113 strains of the organisms submitted by the inspectors and subjected to laboratory examination, 79 were satisfactory and 34 unsatisfactory.

OUTPUT OF BIOLOGICAL PRODUCTS

During the year licensed establishments produced 890,143,751 cubic centimeters of anti-hog-cholera serum, an increase of 4.5 per cent over that of the preceding year, of which 134,034,489 c. c. (15.1 per cent) was defibrinated-blood serum and 756,109,262 c. c. (84.9 per cent) was clarified serum. The corresponding percentages for the previous year were 25.4 per cent and 74.6 per cent. The production of clear serum was approximately 19 per cent greater than that produced during the preceding year.

The quantity of simultaneous hog-cholera virus produced by licensed establishments was 62,805,636 c. c.; of hyperimmunizing virus, 175,629,718 c. c.; and of inoculating virus, 761,481 c. c., making the total production of virus 239,196,835 c. c.

The quantity of other biologics produced by licensed establishments was 40,466,486 doses, in addition to 245,222,575 units of botulinus antitoxin and 289,470,790 units of tetanus antitoxin. These doses are classified as follows: Aggressins, 8,727,036; bacterins, 14,723,577; sera and antisera, 1,206,660; vaccines and viruses, 9,941,553; johnin, 2,691; mallein, 48,699; pullorin, 2,599,315; tuberculin, 2,625,020; and avian tuberculin, 591,935.

PRODUCTS REJECTED

The quantity of anti-hog-cholera serum destroyed as unfit for use in the treatment of animals was 10,820,886 c. c. Of this quantity, 3,058,908 c. c. were derived from animals affected with diseases such as tuberculosis, pneumonia, and septicemia, and the remaining 7,761,978 c. c. were contaminated in the process of manufacture or were otherwise unfit for use.

The total quantity of simultaneous virus destroyed was 2,503,287 c. c., of which 1,154,975 c. c. were destroyed on account of being derived from diseased animals, and 1,348,312 c. c. because of contamination or other unsatisfactory conditions.

The total quantity of hyperimmunizing virus destroyed was 5,329,711 c. c., of which 4,822,292 c. c. were destroyed on account of disease

in the producing animals and 507,419 c. c. because of contamination or other unsatisfactory conditions.

Other biologics amounting to 271,529 doses were removed from the market for various reasons and disposed of under the supervision of inspectors of the division.

EXPORTS AND IMPORTS OF BIOLOGIC PRODUCTS

The bureau continued to exercise control over the importation of veterinary biologics with the cooperation of the Treasury and Post Office Departments and the Food and Drug Administration of the Department of Agriculture. At the close of the year four permits to import such products were outstanding. Bureau inspectors examined at ports of entry 20 shipments of biologics offered for importation. Of these 13 were found to be biologics which had been exported from the United States but were returned for various reasons. Of the remaining 7 shipments, 3 were admitted and 4 were denied entry or destroyed because they were not eligible for importation into this country.

During the year 488 certificates to accompany shipments of veterinary biologics to 27 foreign countries were issued by bureau inspectors. Although certificates are not required in all cases, export shipments were certified by the bureau inspectors, as follows: Anti-hog-cholera serum, 19,730,860 c. c.; hog-cholera virus, 809,052 c. c.; aggressins, 1,156,325 c. c.; bacterins, 399,142 c. c.; diagnostic agents, 6,077 c. c. and 3,780 disks or tablets; sera and antisera, 206,400 c. c. and 292,500 units of tetanus antitoxin; vaccines, 338,251 c. c. and 81,440 doses in powder or disk form.

The total quantity of anti-hog-cholera serum reported released for export purposes was 33,430,971 c. c.

ZOOLOGICAL DIVISION

The scientific investigation of animal parasites and the development of control measures along the lines of treatment and prevention were continued under the direction of Maurice C. Hall, chief.

Facilities for experimental work at Beltsville, Md., were further developed by clearing and fencing additional land.

PARASITES OF POULTRY

COOPERATIVE STUDIES

The results of the study of parasites of quail of the Southeastern States, conducted in cooperation with the Bureau of Biological Survey, were embodied in a report of that investigation, *The Bobwhite Quail, its Habits, Preservation, and Increase*, by Herbert L. Stoddard.

The study of the internal parasites of ruffed grouse, conducted in cooperation with the New England ruffed grouse investigation committee, was continued. To compare the parasites found in grouse that mingled more or less with domesticated birds, as had the grouse studied in recent years in this country, with the parasites of grouse isolated from agriculture and civilization, the viscera of 64 ruffed grouse from the interior of Labrador were examined. The results showed marked differences in the parasitic fauna.

Cooperating with agencies interested in game research in Delaware, the Zoological Division examined Mexican quail which had been introduced into that State and which were dying in considerable numbers. The findings indicate that serious attention should be given to such importations because of the danger of introducing parasites.

In cooperation with the Animal Husbandry Division, studies on the raising of incubator-hatched turkeys on clean range in Montana were continued. This investigation dealt with the parasites of wild birds in that region and with such parasites as have appeared in the turkeys. Parasites were collected during the year from 98 out of 112 wild birds examined. The only worm parasite which has made its appearance in the turkeys was *Heterakis gallinae*; the ring-necked pheasant is considered the probable means by which this parasite was introduced. Coincident with the appearance of this roundworm in the turkey flocks, blackhead also appeared. The number of cases in 1930 was 9 out of approximately 950 birds as compared with 4 out of approximately 750 birds in 1929.

NEMATODES

Detailed studies of the life histories of five nematodes, found as adults in poultry and game birds and as larvae in various arthropods (insects and crustaceans), have been published as a technical bulletin of the department. In addition to the intermediate hosts there reported, cockroaches were found capable of serving as hosts for *Tetrameres americana*.

Cross transmission of nematodes from one species of bird to another was effected in the following instances: *Tetrameres americana* from chickens to turkeys and pigeons; gapeworms from pheasants to chickens; *Capillaria contorta* from quail to turkeys; *Heterakis isolonche* from pheasants to turkeys but not to chickens. In the last case the larval heterakids produced nodules in the wall of the large intestine of turkeys comparable to those produced in pheasants; no clinical effects were noted, though this was possibly due to the fact that the turkeys were adult and the number of parasites was small.

New species of nematodes were found in wild birds of Montana; descriptions of several species have been published. *Ascaridia numida* was reported for the first time as being present in the United States.

CESTODES

Work on the life histories of tapeworms of poultry has been continued. Discoveries of intermediate hosts include two additional species of ground beetles for the tapeworm *Raillietina cesticillus*, the infestations being produced experimentally, and an additional species of ground beetle, *Amara* sp., for the guinea-fowl tapeworm, *Raillietina magninnumida*, this infestation having been acquired in nature. Guinea fowl were experimentally infected with *R. magninnumida*, but attempts to infect chickens and turkeys failed. Only negative results were obtained from attempts to demonstrate a direct development for the tapeworms *R. tetragona* and *R. echinobothrida*.

A morphological study of the larval forms of poultry tapeworms is in progress, as is also a systematic study of the tapeworms of

chickens of the United States. Examinations and identifications of tapeworms have been made of collections from poultry, gallina-ceous game birds, various waterfowl, and other birds.

Treatment of a small number of guinea fowl with kamala indicated that these birds tolerate the doses recommended for chickens.

PROTOZOA

Studies on the control of the cecal type of coccidiosis were continued. These investigations indicate that chickens artificially infected with *Eimeria tenella*, when fed a well-balanced ration containing large quantities of vitamins A and B, have a lower mortality rate, less hemorrhage, and a much lighter infection for the first five or six days, as judged by number of oocysts produced, than those chickens given a diet much poorer in these vitamins. However, during the 18 days of the experiment, the chickens that survived the acute attack of the disease on a poorer diet ultimately made greater gains in weight and were passing fewer oocysts at the end of the test than the chickens on the better diet and with a less acute form of the disease. Much more work along this line is necessary before conclusions can be reached as to the influence of diet on coccidiosis.

Blackhead was found in quail, turkeys, guinea fowl, and chickens. A flagellate which has been observed in the typical blackhead lesions in all these birds was successfully grown on artificial media. A study of the possible relationship of this organism to blackhead is under way.

PARASITES OF SWINE

Investigations were continued in the vicinity of Moultrie, Ga., to determine the habits and survival period of kidney-worm larvae under farm conditions, as a basis for instituting control measures. Under the most favorable conditions infective kidney-worm larvae lived as long as 50 days in winter and as long as 65 days in summer. They lived longer in shaded soil than in that exposed to the sun. Sunlight, apart from its heat, destroyed kidney-worm larvae in about one hour. Natural drying killed the larvae in less than an hour. The infective larvae appear capable of migrating only very short distances; their transfer from one pasture to another probably is brought about largely by driving rain, wind, and other natural agencies.

Examinations of hog lots for kidney-worm larvae yielded the following results: Most of the larvae were found in areas receiving the greatest protection from sunlight, such as beneath corn husks, dead grass, and pine needles, and in weed patches and along shady fences. Although larvae were found occasionally in fields of Bermuda and carpet grass, their occurrence in such areas was infrequent. On one farm where the ground around the farrowing houses was dry during the summer, no kidney worms were found in any of the pigs which were examined post-mortem. On unshaded bare ground no live kidney-worm larvae were recovered at any time during the summer, and the worm eggs from the soil were dead in all cases examined.

The foregoing observations on kidney worms formed the basis of an experimental control measure which is now being tested in

Georgia. Under this system the shelter houses are placed on bare ground, so that the kidney-worm eggs, passed in the urine of infected sows, and the larvae which later emerge from these eggs are killed by exposure to the sun. The sows and pigs are fed separately, and the pigs are raised separately after weaning time. Sixteen farmers are cooperating in this test. Tests are also being made of a slat-floor pen for rearing pigs free from kidney worms, the sows and pigs using separate pastures.

Pigs raised under conditions which precluded extraneous infestations with parasites, except *Strongyloides*, were infected experimentally with one of the nodular worms, *Oesophagostomum longicaudum*, which is of very common occurrence in the South. Post-mortem examination of the pigs 48 hours after experimental infection showed the presence of petechial hemorrhages in the mucosa of the large intestine and cecum; these hemorrhages were produced by parasites which penetrated the mucosa and became encapsulated in it. Ten days after experimental infection, the worms were found in visible nodules located in the walls of the large intestine and cecum. Pigs that ingested nodular-worm larvae had marked digestive disturbances.

Nodular worms also were studied with the view of determining the abundance and distribution of their larvae in hog lots and pastures, especially with reference to conditions which favor their survival. It was found that the larvae of these parasites were more widely distributed and longer lived than kidney-worm larvae and were most abundant in moist soil and beneath droppings of infected animals, apparently having wandered from the droppings after hatching. The larvae were also abundant under the farrowing and shelter houses, in the bedding, on bare, moist soil, and in other locations to which fecal material was carried on the feet of sows and pigs.

Further studies on the life histories of swine lungworms showed that the larvae molt once in the lymphatic vessels, since the presence of fourth-stage larvae is demonstrable in the intestinal lymph glands; they molt again in the lungs and thus attain the final stage and gradually develop to fertile maturity in the lungs. Worms which had attained egg-laying maturity were recovered from the lungs of an experimental pig 24 days after the feeding of infected earthworms.

Investigations have demonstrated conclusively that lungworm eggs and larvae are discharged with the manure of infested pigs. Although it was rather difficult to demonstrate the presence of eggs and larvae by means of any of the known laboratory methods, it was found that earthworms which had been kept in soil mixed with feces obtained from experimentally infected pigs became heavily infected with lungworm larvae, the development of which was studied by dissecting, at frequent intervals, earthworms exposed to this source of infection.

Field investigations conducted in the vicinity of Moultrie, Ga., showed that earthworms were rather scarce in cultivated fields but of common occurrence in adjoining low pastures, particularly those which receive drainage from fields on which hogs or other animals were kept. As determined in the course of these investigations, the ecological relations of species of earthworms, known to serve as inter-

mediate hosts of swine lungworms, indicate that these annelids thrive in permanent hog lots and other places where manure accumulates, and that they are ill adapted to survive in fields which are plowed and cultivated seasonally. It was determined that when pigs were raised on cultivated fields, with the precautions called for in connection with the swine-sanitation system, and not permitted to have access to the pine woods, lungworm infestation in earthworms and in pigs was kept down to a relatively low level; when these precautions were not followed, heavy lungworm infestations in pigs, with resultant unthriftiness, developed in many cases.

Extensive series of tests were made in Washington, D. C., and in Chicago to determine whether the intradermic test for trichinosis was applicable to the ante-mortem diagnosis of this parasitic infestation in pigs. Although it was found that pigs experimentally infected with trichinae became sensitized to the proteins of these parasites and gave more or less clear-cut reactions when an extract of trichina proteins in solution was given them intradermically, many pigs, not experimentally infected, and later found negative for trichinae, also gave reactions to the intradermic injections of trichina antigen. The reactions in the nontrichinous pigs were practically indistinguishable from those observed in pigs experimentally infected with trichinae. Evidently the reaction is nonspecific. From a practical viewpoint, the intradermic test does not appear to offer a solution to the problem of ante-mortem diagnosis of trichinosis in pigs.

Experiments were conducted to determine whether the human hookworm, *Necator americanus*, which is still widely prevalent in the South, is capable of developing to egg-laying maturity in swine. A closely related species, *N. suillus*, known to occur in pigs in Trinidad, has been regarded by certain parasitologists as identical with *N. americanus*, and by other parasitologists as a host variety of the latter. In order to obtain information on the transmissibility of the human hookworm of the South to pigs, experiments were performed which showed that this parasite will not develop in pigs.

In connection with these investigations, guinea pigs were successfully infected with the human hookworm. Although the worms did not attain fertile maturity in these animals, they made considerable growth and their various developmental stages, heretofore unreported, were studied in detail.

An extensive investigation has been conducted to determine whether the gullet worm of swine, *Gongylonema pulchrum*, is biologically, as well as morphologically, identical with the gullet worm of cattle and sheep, *G. scutatum*. Feeding experiments demonstrated conclusively that the gullet worm of sheep can be successfully transmitted to swine, and that the vast majority of the larvae fed to these animals can develop to fertile maturity in the gullet and tongue of these animals. *G. pulchrum* was also transmitted experimentally to rats and guinea pigs, and experiments on the transmission of these parasites to other hosts are in progress. Morphological studies on *Gongylonema* obtained from several species of primates showed these forms to be indistinguishable from one another and from those of swine and ruminants. Specimens of *Gongylonema* obtained from primates were found not only in the wall of the esophagus and in the tongue but also under the mucous membrane of the cheek and

lips. It is interesting to note that the specimens of *Gongylonema* recovered from man have been found under the mucous surface of the lips.

A skin disease of butchers and veterinary inspectors engaged in meat inspection work was studied with the view of determining whether it was due to a sensitization to internal parasites. Although this was found not to be the case, the data pertaining to this dermatitis, supplied by bureau inspectors and others, were analyzed and prepared for publication.

PARASITES OF HORSES

In connection with investigations on the large stomach worms of horses, the larvae of two species of these parasites which develop in house flies were placed on the scarified skin of guinea pigs; no skin lesions and no infestations of the lungs resulted, thus indicating that under the experimental conditions used the two species involved, namely, *Habronema muscae* and *H. megastoma*, are not skin penetrators, and these species are probably not involved in the production of cutaneous habronemiasis in horses. These results lend support to the view of some investigators that *H. microstoma*, a horse stomach worm transmitted by stable flies, is probably the etiological agent of summer sores or cutaneous habronemiasis in horses.

Investigations on the prevalence of the large stomach worms in horses during the winter, when superinfections do not occur owing to the absence of flies, showed that these worms maintain themselves as larvae in horses throughout the cold season. These investigations have brought to light information which probably has a bearing on immunity to nematode infestations in domestic animals.

The preparasitic development of the small stomach worm, *Trichostrongylus axei*, was studied in considerable detail and the following facts were brought to light: The entire preparasitic development is completed in about five days under laboratory conditions. The larvae undergo two molts and in common with those of related trichostrongyles they retain the sheath of the second molt.

In connection with investigations of sarcosporidiosis in horses, a case originating in Kansas was studied in detail, and various stages of the development of the causative parasites in the voluntary muscles were determined. This was the second case of sarcosporidiosis in horses known to occur in this country.

Horse manure buried 3, 10, and 18 inches under the surface of the soil at Miles City, Mont. was found to contain living and active larvae of horse strongyles eight months later, indicating that plowing horse manure under does not of itself destroy the strongyle larvae present. Horse manure exposed to the weather in Montana still contained active strongyle larvae after two years and nine months.

Of 525 horses examined post-mortem at Miles City, Mont., 71 had *Anaplocephala mamillana*, 1 had *A. magna*, and 2 had both.

PARASITES OF RUMINANTS

Nematodirus helvetianus, a nematode of ruminants, previously reported only as a parasite of cattle in Switzerland, was found in cattle in the United States. A species of *Nematodirella*, probably *N. longispiculata*, a nematode hitherto reported only as a parasite of the

reindeer from Russia, was found in the small intestine of a moose in Minnesota.

The program of liver-fluke control has been carried on in California and to some extent in Oregon, Nevada, and Arizona. At the beginning of the project enormous losses of sheep had been sustained in California, in Sonoma, Napa, Lake, Mendocino, Humboldt, Siskiyou, Plumas, Lassen, and Sierra Counties, with smaller losses of sheep already infested when shipped into Sacramento and Tehama Counties. Sheep raising had practically ceased in the valleys in Plumas and Sierra Counties, which had been devastated by flukes before the project was begun. The infested areas were determined by investigational trips and the reports from abattoirs on the condemnation of livers because of fluke infestation.

The control measures advocated were presented to livestock owners by addresses and demonstrations. Livestock periodicals and newspapers also disseminated the same information on the control of flukes. Circulars and posters on the subject likewise were distributed. The result of the campaign was satisfactory; losses have been checked, and no reappearance of the disease has been found in the areas treated except in one instance where the owner neglected to treat the waters annually for the destruction of the snail; this case was soon under control. The work described has placed sheep raising in those counties on a safe basis so far as flukes are concerned and has made sheep stable security for loans by bankers. There has been a saving in feed, the lambing percentage has increased, and the ewes are better able to raise thrifty lambs up to weaning time.

An experimental investigation designed to test the hypothesis that there is an apparent antagonism between tapeworms and tuberculosis showed that the injection of extracts of sheep tapeworms into guinea pigs, experimentally infected with bovine tuberculosis, did not retard the development of this disease.

Attempts to determine the invertebrate carriers of anaplasmosis were continued. So far as concerns transmission by ticks it appears probable that there are other ticks besides *Boophilus annulatus* and *Rhipicephalus sanguineus* in which the etiological agent of anaplasmosis goes through part of a biological cycle, and that the spread of anaplasmosis is due primarily to ticks rather than to the various agencies of mechanical transmission. Methods were developed of using adhesive tape to fasten bags to the ears of rabbits and bovines and also to the scrotums of the latter. Elastic bands were also found to be useful, and by the use of bloomers with such bands it was possible to collect engorged larval ticks from heifers.

Although 10 species of ticks have been or are now being investigated as carriers, only *Boophilus annulatus* and *Rhipicephalus sanguineus* have given positive results thus far.

Cooperative field investigations on cattle grubs were continued. Extraction work formerly conducted in Illinois was discontinued, and the area in Prowers County, Colo., was enlarged from 260 to 435 square miles. The enlarged area contained 9,248 range, farm, and dairy cattle in 320 herds. The cattle were treated for grubs three times.

The nucleus of the Colorado area is a range herd consisting of approximately 1,000 cattle. During the 1928 season all grubs were removed from the central herd as well as from all contact cattle.

The next year the area was enlarged, and in 1930 the borders were again extended. The shortest distance from the borders of the central range to the outer borders of the worked area was 7 miles.

Zone 1, consisting of the central range and all adjoining ranges and farms, has been worked three years; zone 2, consisting of the territory added the second year, has been worked two years; zone 3, the area added last, has been worked one year. The results of the extraction work for the 1930-31 season show that in zone 1 the average number of grubs per animal was 11.6. In zone 2 the corresponding average was 13.6 grubs. Zone 3, an unworked area used for comparison, had an average of 26.9 grubs per animal.

The central or nucleus herd showed, in round numbers: 96 per cent of the cattle to be infested and an average of 35 grubs per animal, the first year; 84 per cent infested and 30 grubs per animal the second year; and 70 per cent infested and 8 grubs per animal the third year.

Labor cost for handling cattle and extracting grubs was 7.4 cents per animal per working, making a total of 22.2 cents per head for the three workings of the last fiscal year. The average number of cattle handled per man per hour was 6.7. The average number of grubs per animal for the entire area was 19.4, and the largest number found in any one animal was 442.

Further work on removal of grubs by vacuum was done. The results show that 98.7 per cent of the grubs on which the vacuum apparatus was tried were extracted. The labor cost per animal was slightly higher and the number of animals worked per man per hour was less than in hand extraction. On long-haired cattle the pressure of the vacuum nozzle binds some of the hairs across the grub opening, thus interfering with the passage of the grub into the container.

Experimental work on killing grubs by inserting medicated rods into the grub sac was continued. The rods were made by forcing the warmed and mixed ingredients through a pressure gun fitted with a small glass tube at the discharge end. The finished rods are about the size of a No. 14 wire and are easily inserted into the grub sac. Acids, alkalies, and the preservatives, thymol and clove oil, are being tried. The use of powdered derris root made into rods with gelatin and glycerin resulted in a 100 per cent kill. A field test with the rods is being conducted.

MISCELLANEOUS PARASITES

Descriptions of several new nematodes were prepared. These parasites included: *Thelazia californiensis*, collected from the eyes of dogs in two widely separated sections of California; 15 nematodes from rodents, described in a manuscript now completed; a species of *Uncinaria* from a Philippine civet and another from the skunk, and a new nematode from the opossum. *Gongylonema neoplasticum*, a species regarded as capable of producing neoplasms in rats, was discovered for the first time in rats in the United States.

A monograph was prepared covering the trematodes of marine mammals, involving a partial revision of 2 families, redescriptions of 10 known species, and descriptions of 3 new species, 1 of which represents a new genus. Two new species of heterophyids, one from

a bird and one from a mammal, were described, and a doubtful member of the family has been restudied. A heavy infestation with an opisthorchid, *Amphimerus* sp., was reported from a turkey from North Dakota, this being the first time a member of this group has been known to infest domestic poultry.

An outbreak of a fatal disease of wild ducks, *Marila affinis*, was investigated near Fort Washington, Md. Apparently a large number of the birds died, as many as 35 sick and dying birds having been observed in a single day. The disease was characterized by an intense hemorrhagic, ulcerative, fibrinous enteritis involving the lower part of the small intestine, and was caused by a small trematode, *Sphaeridiotrema* sp., belonging to the family Psilostomidae. The lesions and causative organism in these cases were the same as those encountered in a similar outbreak in 1928. That this trematode is pathogenic for domesticated waterfowl was shown by specimens received by the bureau from Oregon. These specimens had been collected from the ceca of domestic ducks dying along a water course where they had been feeding.

The monograph on cestodes of carnivores has been continued. *Diphyllbothrium latum* was reported in natural infestations in bears from Alaska and the Yellowstone National Park. Another species of *Diphyllbothrium* was reported from the cat.

TREATMENT FOR INTERNAL AND EXTERNAL PARASITES

The investigations, begun three years ago, dealing with the anthelmintic efficacy of chlorinated alkyl hydrocarbons and the correlation between the anthelmintic efficacy, chemical structure, and physical properties, were completed. The work has resulted in the discovery of at least four compounds which show great promise in the treatment of hookworm disease, and four compounds that show a high degree of efficacy for the treatment of canine ascariasis. The pathological and toxicological phases of the work indicate that these compounds, as far as their action on the liver and their toxicity to the host are concerned, are probably as safe as, or safer than the chlorinated alkyl hydrocarbons which are now extensively used for the treatment of parasitic conditions in human and veterinary medicine. In addition to the discovery of these compounds, the results of the work have afforded certain definite conclusions concerning correlations which exist between anthelmintic efficacy, chemical structure, and physical properties. One of the striking correlations is between anthelmintic efficacy and an optimum range of water solubility.

Halogenated hydrocarbons containing iodine and bromine were found to be more irritant to the gastrointestinal tract of the dog than were those of the same series containing chlorine. The results indicate, in general, that halogenated hydrocarbons containing iodine and bromine possess no greater anthelmintic efficacy for hookworms in the dog than do the halogenated hydrocarbons containing chlorine. Results seem to warrant the tentative conclusion that the water solubility of halogenated hydrocarbons is of greater importance in relation to anthelmintic efficacy for hookworms in the dog than is the kind of halogen atom in the hydrocarbon molecule.

In view of the demand for information concerning treatment for various parasites infesting cats, critical tests with a number of drugs were carried out on these animals. Results of these tests indicate that tetrachlorethylene in a dose of 0.2 cubic centimeter per kilo of body weight, followed in five hours by an adequate dose of castor oil, is usually 100 per cent effective for the removal of ascarids and hookworms from the cat. Arecoline hydrobromide administered in tablet form in doses of one twenty-fifth to one-fourth grain removed all the tapeworms present in 50 per cent of the cats harboring these parasites but left all the worms in the others.

In the treatment of rabbits for parasites it was found that tetrachlorethylene in a dose of 0.5 cubic centimeter per kilo will frequently remove a large percentage of stomach worms, *Obeliscoides cuniculi*.

Hexyl resorcinol, which has been found by investigators outside the bureau to be an effective treatment for the removal of ascarids from the dog and man, and partly effective for the removal of hookworms from man, was tested on swine. This drug proved to be inferior to oil of chenopodium for the removal of ascarids from swine. In the absence of any effective treatment for the removal of nodular worms from swine, hexyl resorcinol seems promising, but its high cost and the necessity for a long period of fasting before treatment are objections to its use.

In the course of investigations with chlorinated alkyl hydrocarbons, normal butylidene chloride was found to be highly effective against ascarids and hookworms in the dog. Results of experiments on eight horses indicated that the same drug is a promising treatment for equine strongylidosis. It was well tolerated and produced no gross pathological conditions.

In view of the fact that no effective treatment has been available for the destruction of *Habronema* spp. in the stomach of the horse, and because these parasites are of considerable economic importance, critical tests with a number of drugs were carried out. Carbon disulphide at a dose rate of 6 fluid drams (24 c. c.) for a 1,000-pound animal, preceded by a preliminary washing of the stomach with 8 to 10 liters of a 2 per cent solution of soda bicarbonate, resulted in a high degree of efficacy for the destruction of *H. muscae*. The drug was without effect on *H. megastoma* located in tumors in the wall of the stomach. Carbon disulphide administered without preliminary gastric lavage gave less promising results.

INDEX CATALOGUE AND COLLECTION

The index catalogue of medical and veterinary zoology was continued and preparations were made to begin publication of the author catalogue, reprinting the previous author catalogue with the additions necessary to bring it up to date. There were 976 accessions of specimens of parasites to the helminthological collection.

REPORT OF THE CHIEF OF THE BUREAU OF CHEMISTRY AND SOILS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY AND SOILS,
Washington, D. C., August 31, 1931.

SIR: I present herewith the report of the Bureau of Chemistry and Soils for the fiscal year ended June 30, 1931.

Respectfully,

HENRY G. KNIGHT,
Chief of Bureau.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The Bureau of Chemistry and Soils is engaged in perfecting a nation-wide inventory of the soil-fertility resources of the United States to serve as the basis for a land classification whereby the Nation, the States, and individual farmers will be enabled to develop more efficient and profitable agriculture by the proper adaptation of crops to soils. With the object of assisting American farmers to more economical and profitable crop production, the bureau is constantly seeking new and cheaper sources of fertilizer and is continuously engaged in perfecting and cheapening methods of fertilizer manufacture and fertilizer application. The bureau is working steadily on the problem of profitable utilization of farm by-products and farm refuse, and the object of much of its research work is the widening and improvement of markets for farm by-products, surpluses, and refuse, by demonstrating their value as sources of raw material for industry and consequently as sources of increased income for the farmer.

The research and fact finding of the bureau, as they relate to the plant-food resources of the Nation, the economic utilization of soils, the development and effective use of our fertilizer resources, and the utilization of crop wastes and surpluses by manufacturing industries, are of the utmost importance to producers and consumers of farm crops and the manufacturers who convert these crops into commercial products.

Under the 131 major lines of inquiry recognized as projects, the Bureau of Chemistry and Soils is actively prosecuting investigations on 559 subprojects. The major lines of inquiry are continuous, or at least cover a period of years, whereas the subprojects, which represent the detailed activities of the bureau at any given period, have

time limits placed on them, and when completed they are succeeded by others usually along the same line of inquiry. Within this organization are the soil survey, which is mapping soil areas and laying the foundation for the study of the Nation's soil resources; soil-erosion studies, which aid in reducing losses from soil washing and in controlling flood water; soil-fertility studies, having for their purpose a better utilization of the soil; and finally the application of engineering and chemical technology to the study of fertilizer resources and the more economical and diversified utilization of the products of the soil.

The research work now in progress includes investigations in soil chemistry, soil physics, soil erosion, soil microbiology, soil fertility, nitrogen fixation, potash and phosphate resources, crop chemistry, fruit and vegetable chemistry, fermentation methods for the production of organic acids, the utilization of farm and industrial wastes, food microbiology, food deterioration and spoilage, dust explosions and farm fires, and improvements in the technic of producing sirups, sugars, vegetable oils, proteins, insecticides, fungicides, tanning materials, and a variety of other products.

For the purpose of administration three large units are recognized within the bureau—(1) chemical and technological research, (2) soil investigations, and (3) fertilizer and fixed-nitrogen investigations. Each of the three units is under a chief scientist, who not only directs the work of his unit but also serves as a member of an informal coordinating board within the bureau. By virtue of its broad field of activities and the coordinated effort within the bureau, the organization is given the opportunity to attack problems along very broad lines.

In the main, appropriations are made to the bureau for the purpose of attacking specific problems, the solution of which is of benefit to the business of agriculture and has, therefore, a utilitarian objective. Direct attack upon some of these problems, however, in the absence of essential fundamental knowledge, would be wasteful of funds and energy. Search for the fundamental knowledge is therefore often necessary, and it may lead the investigator into the realms of pure science, where a foundation is laid for the logical attack and final solution of the problem under consideration. Such a method of attack requires careful, thoughtful planning, the development of skilled technic, intelligent and discriminating analysis of results, and ability of a high order to make the necessary practical applications.

Although the bureau encourages the development of more research in the realm of pure science, it is always with the definite object of solving some practical problem. The results of such research may have a very wide application in fields far removed from agriculture or industries based on agriculture, so that in such cases the bureau contributes materially to the advance of science in general. Research for research's sake without regard to practical applications in the fields assigned to the bureau has no place in this organization.

To an increasing extent the work of the bureau is carried on in cooperation with the States, and its cooperation with industrial groups is also increasing. For a period of more than 30 years the soil survey has been conducted on a national scale in cooperation

with the several States which have usually shared expenses equally with the bureau. Soil-erosion work is now conducted in cooperation with seven States. Much of the soil-fertility work is in cooperation with the agricultural experiment stations of the several States, and wherever it seems practical and desirable other research is carried on cooperatively. The bureau makes very close contacts with industrial groups utilizing agricultural materials or manufacturing the finished products primarily for use on the farm.

It is estimated that in gross tonnage farm by-products constitute more than 60 per cent of the materials that are removed from the land. It is estimated that there is a total of 260,570,000 tons of agricultural materials for which the farmer now fails to get a return at all commensurate with the cost of soil fertility and labor expended in their production. These materials have in them part of the farmer's assets—that is, the fertility of his land, the advantage of his climate, and the fruits of his labor—but they bring an insignificant return. Because so much of the costs of agriculture is tied up in farm products it is evident that their profitable utilization will result in a greater return and is of greater economic importance to the farmer, under present conditions, than increased production, because these products are at hand and ready for use, whereas increased crop production requires further expenditure of soil fertility and of the time, energy, and money of the farmer. With these facts in view the bureau is constantly engaged in research, seeking a more economical utilization of farm products in the manufacture of articles of commerce and the production of more uniform final products, which will benefit the farmer and the ultimate consumer.

This widening of markets for farm products through the development of new channels for their industrial utilization is one of the most important functions of the bureau. Painstaking research and the application of the results to the problems of industry are the only way that this may be brought about. New industries have arisen during the last few years which use as their raw materials the products of agriculture. Numerous examples may be cited where waste has been converted into valuable commodities, but the greatest agricultural waste, the crop residues, consisting of stalks, straw, hulls, etc., are still awaiting wide industrial uses. If the history of the past is to be repeated such waste of to-day will become important raw material for the use of industry to-morrow, and the Bureau of Chemistry and Soils is working constantly toward that objective.

The detailed mapping and description of 28,530 square miles of soils in 30 States and in Porto Rico and the Virgin Islands during the past year, and reconnaissance surveys covering 14,014 square miles in Montana, Minnesota, Oklahoma, and Vermont, bring the entire area of soils which the bureau has mapped to date to a total of 1,449,792 square miles, or 927,866,880 acres. The extent of the work which the soil survey has accomplished can be judged from the fact that this total area is nearly three times as great as the combined (European) areas of France, Germany, and Great Britain. Impressive as these figures are, their size alone does not convey an idea of the great importance of this inventory of the resources of American farmers and its relation to the agriculture of the United States.

While the growing demands of farmers for the soil survey indicate its increasing value to farm producers in every State in the Union, it has very special importance at the present time as a guide in regional and national problems of agriculture because of the present readjustments in farm practice. Obviously the soil survey furnishes the information upon which the future inevitable land classification of this country must be based. In fact no land classification based on the natural productive capacity and the natural adaptability of soils to crops is possible without the facts supplied by the soil survey.

By the use of the soil survey and in cooperation with the soil fertility division of the Bureau of Chemistry and Soils, entire regions and States have been enabled to add many millions of dollars to their farm income in recent years. One such example is furnished by the growth of the tobacco industry in Georgia; another is afforded by the benefits derived from the use of phosphatic fertilizers on western sugar-beet soils as recommended by soil fertility specialists of the bureau. Within the past year a reconnaissance survey of the principal sugarcane areas of Louisiana was completed, and specialists from the bureau, in cooperation with State workers, by means of fertilizer experiments, demonstrated the kinds and amounts of fertilizer most effective on the dominant sugarcane soils. Such assistance will undoubtedly prove of timely benefit in helping the sugarcane planters to adopt more economical methods of production, thereby increasing their margin of profit at a period of peculiar economic depression. Similarly within the past fiscal year farmers of one of the most important strawberry-growing districts of the South have been enabled to increase their receipts by approximately \$75 an acre by adopting new fertilizer practices recommended by the bureau. The bureau has also assisted in laying the foundation for the solution of certain agricultural problems in Porto Rico and the Virgin Islands where it has completed the field work for detailed surveys during the past year.

New developments in fertilizer manufacture during recent years are changing the entire fertilizer industry. At no time in its history has this industry depended to such an extent on research for its prosperity and its economy of operation as to-day. The research of the bureau in this field has been very effective in aiding economy of production which continues to reflect direct benefit to agriculture in the form of cheaper and more satisfactory sources of plant-food materials. Such researches, directed to the development of a more advanced national agricultural program, have become recognized as primary functions of the Federal Government.

During recent years the farmers of the United States have spent about \$250,000,000 annually for commercial fertilizer. The amount has been somewhat less during the past year, but it offers ample proof of the necessity for commercial fertilizer in American farming and justifies the efforts that are being made to bring about improvements that will result in the farmers getting more for the money invested in this material. During the past year progress was made in improving methods of converting nitrogen, phosphoric acid, potash, and other materials into fertilizers and of making them of greater benefit to farmers by lowering the cost, by increasing the plant-food content, by improving the drillability, and by developing

more advanced methods of applying them to crops. Imports are still the source of 80 per cent of the potash used by American farmers, but American production is on the increase and is now supplying more than 100,000 tons of fertilizer salts. Investigations are being made by the fertilizer and fixed nitrogen investigations unit of the bureau to find commercially feasible methods for the production of suitable potash materials from the various potash minerals that are known to exist in great quantities in various parts of the United States. It is anticipated that the bureau's researches on the blast furnace will result in the more economical production of potash and phosphoric acid fertilizer in various regions of the United States.

The nitrogen-fixation industry, to which this bureau has given assistance through a comprehensive research program covering a period of years, is now a thoroughly established and functioning producer of cheap nitrogen. An important new development in which the bureau has assisted to make this cheap nitrogen still more useful has been demonstrated to affect also the supply of phosphates. Probably the most interesting and important of the recent developments in fertilizer manufacture is the direct use of synthetic ammonia in fertilizer mixtures containing superphosphates, and recent studies by the bureau indicate that it should be possible at least to double the quantity of free ammonia now used in fertilizer mixtures without decreasing appreciably the value of phosphoric acid in the mixture. Steps are accordingly being taken by the official organization of the State control chemists which will allow an increase of about 100 per cent in the use of free ammonia in fertilizer mixtures. This will provide for an increase in the use of synthetic ammonia in this country of at least 80,000 tons annually, having a wholesale value of about \$8,000,000.

The bureau has recently demonstrated, in cooperation with one of the State experiment stations, that at least a 10 per cent saving in fertilizer can be realized by uniform distribution in the field. The bureau has also been instrumental in fostering a program for increased plant-food content in fertilizers, which means a proportional saving in freight, handling, and sacking costs. The average plant-food content has increased from about 15 per cent in 1920 to about 18 per cent in 1930, with every indication that the increase will continue. The bureau has cooperated in the past with as many as 25 State experiment stations at one time in testing out new fertilizer salts and fertilizer mixtures with a view to determining their suitability for plant growth on the respective soils.

During the past year the output of information from this bureau, both in the form of official publications printed by the department and articles by scientific workers published in technical and scientific journals, has greatly increased. Seventy-four new publications from this bureau, exclusive of Yearbook articles and the annual report of the chief of the bureau, were printed by the department. These included 52 soil-survey reports, 7 technical bulletins, 3 circulars, 3 leaflets, 1 farmers' bulletin, and 8 articles in the Journal of Agricultural Research. The number of soil-survey reports published in 1930-31 is the largest in any one year since the organization of the bureau and brings the reports much closer to date than has been the case for a number of years. The technical bulletins and

circulars present valuable findings of the bureau on soils and chemical and technological research. The 139 articles by scientific workers of the bureau, which have appeared in technical and scientific journals and other publications, have furnished other scientists and the public the latest information on the progress of research carried on by the three units of the bureau.

From its editorial office the bureau has continued to increase its output of information to the press and has sent out a large number of news releases of timely interest on the varied work of its units. It is constantly cooperating with the press service and the radio service of the department's office of information in furnishing information to the public and to the special or regional groups which it can serve best.

CHEMICAL AND TECHNOLOGICAL RESEARCH

The work of the unit of chemical and technological research includes primarily investigations which relate to the study of the carbohydrates, fats, proteins, vitamins, essential oils, organic acids, tannins, lignin, and other constituents of agricultural produce; to the improvement of methods for their determination, separation, and purification; and to the discovery of new processes for their industrial utilization.

The conversion of the surpluses and wastes of agriculture into products of commercial value is a general project of outstanding importance. It has been estimated that the straw, stalks, hulls, and other residues of several leading crops of the United States constitute an aggregate of more than 260,000,000 tons with a calculated content of approximately 115,000,000 tons of cellulose, 66,000,000 tons of pentosans, and 53,000,000 tons of lignin. The development of processes for the industrial utilization of these vast untapped reserves of potential wealth will add many millions to the value of our agricultural products.

In addition to the studies relating to the proximate organic constituents of crops, the unit of chemical and technological research conducts another important class of researches which have for their object the discovery and improvement of methods for protecting foods and other farm products against the destructive action of insects; molds, bacteria, and other microorganisms; enzymes; atmospheric influences, such as light, heat, humidity, and deleterious gases; explosions and fires; and miscellaneous chemical changes, such as oxidation and reduction. The loss to American agriculture from these various causes amounts each year to more than \$1,000,000,000, and the reduction or prevention of this great drain on our agricultural prosperity is another leading purpose of the research work of this unit.

The varied researches of this unit during the present and preceding years have been conducted with constant attention to the correlation of the theoretical and practical phases of the work. This has involved, first of all, fundamental researches on the chemical nature of the numerous organic and inorganic constituents of our agricultural products and of their mutual relationships to one another, and secondly, thorough technological applications of the fundamental knowl-

edge thus acquired to the practical problems of nutrition, food preservation, and the manufacture of leather, paper, naval stores, dyestuffs, sugar, starch, fats and oils, insecticides, and other industrial products.

A close correlation between the work of the chemical and technological research unit and that of other governmental and State institutions is also maintained, and, as a result of this, many collaborative investigations have been conducted by the scientists of this unit with those of other bureaus. Such cooperation has resulted in a more comprehensive understanding of the highly complex factors which characterize so many phases of agricultural research and also in a strengthening of the esprit de corps of the department as a whole.

CARBOHYDRATE INVESTIGATIONS

CANE SIRUP

Important progress was made on the problem of producing sirup of higher quality and more uniform grade on individual farms. Cane sirup is an important cash crop on more than 270,000 farms in the South, about 2,000,000 tons of sugarcane with a value of \$12,000,000 having been grown for sirup production in 1930. On account of the great variation in the quality of cane sirup made on different farms, producers are greatly handicapped in marketing their product for direct consumption, and an increasing proportion is going through the hands of commercial blenders. This has tended to reduce farm-made cane sirup to the status of a raw material in another industry, thus degrading the price.

Experiments were conducted on the possible use of various decolorizing carbons for treating sugarcane juice to improve the quality of the sirup. Juice from selected lots of sugarcane representing as definite cultural and varietal conditions as possible was used for sirup making, a careful record being kept of all data available relative to variety, fertilizer, soil, and conditions of growth. The results of the work to date indicate that activated decolorizing carbons may be used to advantage by small-scale sirup producers. It is believed that a comparatively simple procedure for use on the farm can be developed after further study has been made of the use of carbons in typical farm-sirup evaporators.

CANE SUGAR

Investigation of the composition of cane juice and the influence thereon of various cultural and varietal factors was continued, attention being given also to investigation of the basic principles of clarification of cane juice. In many cases ineffective clarification is the result of "refractory" juices which reflect the influence of adverse cultural conditions.

The juice of sugarcane grown on soil of certain types was found to be deficient in phosphate, and the addition of commercial phosphoric acid improved the clarification and resulted in the production of raw sugar of greatly improved quality. In general, the filterability of sirups and sugars obtained from the clarified juice of cane from various areas correlated well with the phosphate content of the juice,

but a number of exceptions indicate that in many cases the phosphate present is not in available form for reaction with lime and precipitation as calcium phosphate. A method was devised whereby it is possible to determine the proportion of the phosphorus compounds in the juice which are available for clarification reactions.

Studies were made of the deterioration of sugarcane in Louisiana as a result of freezes at harvesting time, and it was found that the juice of such cane contained unusually large quantities of d-mannitol and the gum dextran. Mannitol was present in such quantities as to crystallize from molasses.

The composition of various fractions of sugar juice was investigated with reference to clarification of the juice and its suitability for production of different grades of sugar, sirup, and molasses. The possibility of employing different methods and degrees of clarification to partly eliminate characteristic differences in juice composition was further investigated. This work is intended to furnish chemical and chemical-technological information, which will be useful for supplementing the data customarily employed for selection of the most suitable varieties of sugarcane for general cultivation in continental United States. The work has also yielded considerable chemical data on improved clarification methods for production of raw sugar of better quality and production of white sugar on the plantation without oversupplying the market with edible molasses as a by-product.

In studying the variable composition of sugarcane juice, considerable information was gained relative to the elimination of gums, iron, ash, phosphates, sulphates, colloidal matter, and coloring substances by different methods of juice clarification. A study was also made of the extent to which colloidal substances are eliminated from cane juice by different clarification procedures.

BEET SUGAR

Investigation of various nonsugar constituents of sugar-beet juice, which have an adverse effect on yield and quality of sugar, was continued, attention being given to possible correlations between the amounts of these nonsugar substances and various factors, such as kind of soil, fertilizer, weather conditions, and storage. Methods were improved or devised for the determination of the following nonsugar compounds in the presence of a considerable excess of sucrose in sugar-beet juice and products derived therefrom: Inorganic and organic phosphorus compounds, labile organic sulphur, sulphates, sulphites and aldehyde-sulphites, and various nitrogenous compounds.

A large number of samples of beet sugar and other products from sugar-beet juice representing beets grown under a great variety of cultural conditions were investigated. The examination of these samples has not yet been completed, but it is anticipated that the data will indicate some correlation between cultural factors such as kind of soil and fertilizer on the one hand, and content of various nonsugar compounds, such as phosphates, organic phosphorus compounds, and inorganic and organic nitrogen compounds, on the other hand. In general, the samples of beet sugar collected during the

season of 1930 were of better quality than those of the preceding season. This improvement is attributed, to a considerable degree, to improvements in juice clarification resulting from suggestions derived from this investigation.

MAPLE SIRUP

In cooperation with a commercial manufacturer, semipermanent liquid maple-sirup color standards were developed and have been placed on the market. Another manufacturer, to whom cooperation has been furnished, is developing a set of permanent glass color standards for maple sirup. These color standards will be of great value to maple-sirup producers by enabling them to produce maple sirup of higher grade and greater uniformity of quality and thereby to obtain an increased financial return.

Although the production of maple sugar and maple sirup is not an extensive industry, it is an important one in the producing sections, particularly as it provides a cash crop. Almost 4,000,000 gallons of maple sirup and 2,600,000 pounds of maple sugar were produced in the United States in 1930.

HONEY

During the past year attention was directed principally to investigation of the colloids of honey from the standpoint of their influence on quality. It was found that these colloidal substances possess a positive electric charge. A method based on this fact was devised whereby the colloids of honey may be flocculated by means of the colloidal clay bentonite possessing a negative electric charge. This method of clarification yields honeys of brilliantly clear appearance and apparently with diminished tendency to undergo granulation. The procedure has not yet been developed on a suitable commercial basis, and the investigation is being continued with that end in view.

A study was made of the quantity and composition of the colloidal constituents present in honey and their influence on such properties of honey as caramelization temperature, color, granulation, viscosity, and tendency to foam. These data have been obtained in the case of honeys from a great variety of floral sources. The colloidal material consists, for the most part, of nitrogenous compounds, highly emulsified wax particles, gums, and inorganic substances, such as calcium, iron, and silicon compounds.

UTILIZATION OF CULL AND SURPLUS SWEETPOTATOES

Investigation of the possibility of utilizing cull and surplus sweetpotatoes for production of starch was continued. One of the principal difficulties in obtaining starch of suitable quality from sweetpotatoes was solved in the course of the past year's work. By the use of a process in which sulphur dioxide is applied during the process of grinding the sweetpotatoes and a very dilute solution of sodium hydroxide is used at a later stage in the purification of the starch it has been found possible to produce starch of prime quality and fine white color, regardless of the variety of the potatoes and whether or not they have been stored. This increases the probability of develop-

ing a profitable means of utilization of cull sweetpotatoes on a commercially practical basis.

Investigation was also made of various possibilities of utilizing the residual pulp and the more concentrated portions of the waste water as by-products. A satisfactory basis for cattle feed may be obtained by concentrating the portions of waste water of higher density to a sirupy consistence, mixing with the residual pulp, and drying. This product is somewhat deficient in protein, but when mixed with a product such as peanut, soybean, or cottonseed meal a palatable cattle feed of good quality and satisfactory composition is obtained.

CARBOHYDRATES IN WILD DOMESTIC PLANTS

In carrying out a systematic investigation of the latent and potential plant resources of the country, about 60 native uncultivated plants were analyzed for carbohydrates and incidentally for other compounds. Inulin in considerable quantities was found in several plants which have been widely used for food by the Indians of the United States. Very little inulin is contained in the present diet in the United States, although inclusion of this substance in our diet has been repeatedly advocated by investigators in nutrition, particularly with respect to prevention and treatment of diabetes. Knowledge of the chemical and physiological properties of inulin is, however, still very meager. Supplies of pure inulin from various plant sources have been prepared for the purpose of studying its chemical and other properties.

FOOD RESEARCH INVESTIGATIONS

PRESERVATION OF FRUIT JUICES AND PULPS

The importance of the fruit-juice industry is increasing rapidly from year to year. More than 5,000 gallons a day of orange juice is being frozen in one plant in Florida, and carload shipments are being sent from California. Greater knowledge is needed of the limitations of preservation by freezing, especially of the causes of deterioration during prolonged storage.

During the past year the bureau has endeavored to reveal some of the causes of deterioration of frozen fruit juices. More than 900 containers, consisting of different types of bottles, jars, and cans filled with different fruit juices, fruit hearts, and slices, with and without sugar sirup, packed under atmospheric pressure and under 26 inches of vacuum, have been frozen at various temperatures and kept in cold storage. Results have shown that, when carefully prepared, orange juice and slices and grapefruit juice and hearts can be preserved in this way for a year with little loss of flavor, and pineapple juice and slices retain the natural flavor of the fruit to a high degree.

An important development, which bears directly on the distribution of frozen products, is that when juices and fruit products are defrosted after a long period of storage and placed in the ordinary ice box without opening the package, they will keep for more than 60 days with little loss of flavor. The samples packed under 26 inches of vacuum retained from 22 to 23 inches.

In addition to the investigation of freezing fruits and juices, the subject of preservation by other means has been studied. At the present time a series of tests using helium gas is under way, and others using oxygen, nitrogen, and carbon dioxide are planned.

GRAPEFRUIT BY-PRODUCTS

A continuation of the study of utilization of waste from grapefruit canneries was carried on during the year, and methods devised for use on oranges were modified to fit conditions found in grapefruit cannery waste. Studies on the production of naringin, the glucoside present in the fruit, were made, and methods are now available for producing naringin in considerable quantities at low cost. The question of turning the waste of grapefruit canneries and juice factories into acceptable cattle or chicken food has also been studied, and arrangements are being made for actual drying experiments.

SPOILAGE OF FROZEN VEGETABLES

Studies on the possibility of botulinus poisoning arising from the consumption of spoiled defrosted vegetables have been carried on both from the cultural standpoint and from the standpoint of commercial practice. Experiments with spores of *Clostridium botulinum* prepared in dry form, which most closely resembles their natural condition in the soil, suspended in solution simulating the effect found in vegetables and frozen by different methods, show that neither the rapid nor the slow freeze kills the spores or liberates toxin from them. This is very important, for, interpreted in commercial practice, it means that defrosted vegetables will have just as many living spores as were present originally when the material was prepared. These tests have been run on widely different strains of the *C. botulinum* with exactly duplicate results. Similar experiments, in which the spore suspensions have remained frozen for varying periods of time, have shown that long-freezing storage does not kill the spores or release toxin.

The possible significance of the spores in the spoilage of frozen vegetables is being studied also by the preparation of fresh peas, as follows: Inoculation with the botulinus spores, freezing, defrosting, and holding under various conditions. Samples were prepared containing a heavy inoculation, light inoculation, and no inoculation, and four different types of containers have been included. Several containers have been found to be toxic, and the toxin has been identified. Many containers, both inoculated and not inoculated, have yielded botulinus organisms, and botulinus toxin has been found and identified in uninoculated containers.

PRESERVATION OF FOOD PRODUCTS

Further studies on the production of sauerkraut from surplus turnips have been made with special reference, (1) to the most suitable methods of cutting and packing in order to obtain the best fermentation, and (2) to the use of different turnip varieties for this fermentation. Repeated experiments have shown that either grind-

ing or shredding the turnips promotes lactic fermentation, whereas slicing markedly interferes with it. The results of the variety tests are not yet available.

RANCIDITY IN FOOD PRODUCTS

Experiments on the delay or prevention of rancidity in rice mill and other products seem to show that light plays a most important rôle in influencing the keeping quality of foods. A new field of research is thus indicated.

BAKING INVESTIGATIONS

A new series of investigations in cake making was conducted, using wheat germ as a part substitute for wheat flour. It was found that cake of very good appearance and of excellent flavor resulted from the use of 25 to 30 per cent of wheat germ. Wheat germ is rich in vitamins A, B, G, and E, and can be successfully used in all baked products and especially in the making of cake where egg whites instead of the whole egg or egg yolk are used.

In collaboration with the Bureau of Fisheries, very successful experiments have been carried on in the use of 10 to 15 per cent of fish flour, a specially prepared and biologically pure product, in making cookies flavored so highly with ginger or cinnamon that the taste of the fish is practically hidden. This fish flour contains 20 to 30 per cent of easily assimilated calcium phosphate.

Experiments in baking by using so-called water-retaining and stale-retarding agents indicate that these substances have but little effect in retarding staling. Experiments in keeping bread at comparatively high and at very low temperatures for three or four days seem to indicate some delay in staling.

PRESERVATION OF EGGS

Studies on the preservation of shell eggs by oiling have led to the development of a new method of treating eggs under a vacuum. Fresh graded eggs treated by various methods were placed in commercial cold storage for 11 months and then reggraded. The vacuum-oiled eggs retained their original high quality far better than did any of the other lots.

Studies have also been made of the amount of oil taken up by the eggs under different methods of treatment. Although in the vacuum method the oil is carried through the shell pores, microscopic examinations show that the oil does not penetrate the egg membrane but remains between the membrane and the shell.

PLANT PIGMENTS

Investigations of naturally occurring vegetable coloring matters were directed particularly to a study of the pigments of tomatoes and apples.

Tomatoes constitute an important truck crop both in the fresh state and in canned form, the estimated acreage in 1929 being about 450,000 acres which yielded a total of 1,900,000 tons of tomatoes. In recent years there has been a very great increase in imports of tomato

products, the value of such imports in 1929 being more than \$10,000,000, and this increase is largely attributable to the superior color of the imported products. Studies on tomato pigments have been started with the view of determining the factors influencing color formation in fresh tomatoes and deterioration of color in canned and preserved products. During the past year raw materials, consisting of various foreign and domestic tomato pastes, were collected, and considerable quantities of red coloring matter were isolated, which will be further purified and thoroughly investigated chemically and physically. Crystalline carotin has also been obtained from tomatoes.

One of the important problems confronting apple growers is the production of highly colored fruit. In 1930 the production of apples in the United States amounted to 163,543,000 bushels, having a total estimated farm price value of \$152,546,000. A pleasing color appearance not only has an appreciable effect on the market value but also is responsible for an enhanced value from a nutritive standpoint. Preliminary investigations of the chemical nature of the coloring matters and of the factors influencing their formation have shown that flavonol or yellow pigments are the mother substances of red or anthocyanin pigments. A flavonol has been isolated and identified from red apples, and the presence of a similar substance has been shown in yellow apples. Further work will be carried out on these types of pigments and the investigations extended to the corresponding red coloring matters.

VEGETABLE SURFACE COVERING

Knowledge of the composition, quantities, and functions of the waxy coating and cutin of fruits and vegetables is very meager, in spite of the commercial and agricultural importance of the botanical entity known as plant cuticle. This covering plays a most important rôle in the application and subsequent removal of sprays, resistance to injury by fungi, bacteria, and insects, and in the keeping qualities of fruits on the market and in storage. During the past year quantitative determinations were made of the various constituents of the waxy coating of 17 varieties of apples from the States of Washington and New York. Determinations were also made of the permeability of the skins as measured by evaporation losses. A satisfactory method for determining the quantity of cutin in apples was developed, and investigation of the chemical composition of cutin in tomatoes and apples has been started.

ACIDS OF GREEN VEGETABLES

An investigation was made of the organic acids of broccoli, cabbage, lettuce, and spinach. As no analyses of broccoli were found in the literature, the examination of this vegetable was made rather complete and showed that the leaves and buds have materially the same composition and nutritive value. Both buds and leaves contain proteins somewhat in excess of that reported in spinach. The predominating organic acid in broccoli is citric acid. It also contains *l*-malic acid and small amounts of oxalic and succinic acids.

The organic acids of lettuce were found to be *l*-malic acid, citric acid, and oxalic acid. The percentage of oxalic acid was found to be 0.011.

Fresh spinach was found to contain 0.31 per cent of oxalic acid. Citric acid and a small amount of *l*-malic acid were isolated.

The study of the acids of wheat seedlings was extended to include barley, corn, oats, and rye plants. All these plants were found to contain aconitic, malic, citric, and oxalic acids. The occurrence of aconitic acid in all plants of the Gramineae, or grass family, so far examined, including sugarcane and sorghum, is noteworthy. A paper embodying the results of this work has been submitted for publication in the Journal of the American Chemical Society.

INDUSTRIAL FARM PRODUCTS DIVISION

HIDES AND SKINS

Hides and skins are the base goods of all leather. Every pound of hide substance lost through spoilage and waste is a complete loss of its equivalent yield of leather. It is estimated that our annual loss from poor handling of hides and skins is at least \$20,000,000. The bureau's work on hides and skins bears directly and indirectly on reducing this waste.

Field work of the bureau among butchers and dealers on correcting poor practices in skinning and curing is gaining in favor among the trade, and in spite of the many difficulties, economic and otherwise, progress is being made. During the year more than 700 personal calls on butchers, dealers, and tanners have been made by the bureau's hide specialists. On repeat calls it has been found that corrections have often been adopted and have resulted not only in better hides and skins but also in greater financial returns to the producers.

Study of the reddening of salt-cured hides has been intensively pursued during the year and some progress has been made. This reddening is recognized by the trade as an abnormal condition and is consequently looked on by the buyer with suspicion and some concern as to the effect that might develop therefrom later in the tanning. More than 200 samples of salt have been examined for their ability to develop red growth on laboratory media. Of 36 samples of solar salt, 34 developed a red growth, as did also 25 out of 39 samples of open-pan evaporated salts. Of the 62 samples of mined salt and the 17 samples of vacuum-pan evaporated salts examined none showed red growth.

TANNING MATERIALS

This country imports about one-third of the \$25,000,000 worth of tanning materials used each year. Furthermore, more than half of the domestic supply of tannin is now being obtained from only one source, the wood of the American chestnut tree, which, it is realized, is doomed by the chestnut blight. In recognition of this the work on tanning materials is mainly directed toward the discovery and development of possible new sources of tannin and the conservation of established sources through better methods of produc-

ing and handling and more economic and efficient processes of tanning.

Because of the important international trade in tanning materials, the bureau is actively cooperating with the American Leather Chemists' Association in the recently revived movement to set up international methods of tanning analysis. In collaboration with a committee of that association an elaborate comparative study has been made of several procedures to determine the insolubles in tanning extracts, a determination that is now one of the moot questions in the proposed international methods.

In connection with the possible exploitation and development of Florida mangrove bark, a recently submitted sample of this material was examined. Analysis showed it to contain, on the moisture-free basis, 26 per cent tannin and 13.5 per cent nontannins. Although this would place the bark among those rich in tannin, the content is about 10 per cent less than that of the imported mangrove bark at present competing.

The utilization of pine bark in the South as a source of tannin in connection with the simultaneous use of the wood as a source of fiber is receiving attention. Analyses of a few preliminary samples have indicated, in some cases, an encouraging tannin content.

Active cooperation has been continued with the Bureau of Plant Industry, in examining for tannin many foreign barks and woods which that bureau is collecting in connection with its work on discovering and introducing into this country substitutes or replacements for the American chestnut tree. During the year about 100 analyses were made of additional specimens from Japan, Taiwan (Formosa), and China. Those which from their tannin content deserve especial attention are the bark of *Quercus dentata*, *Q. sessilifolia*, *Castanopsis subacuminata*, *Myrica adenaphora kusanoi*, and both the bark and wood of *Lithocarpus konishii*.

The results of an examination of young Chinese chestnut trees grown at Bell, Md., are being assembled for publication. Probably the most interesting point brought out by the data is that the tannin content of the bark and wood of these trees is practically the same as that of near-by second-growth American chestnut trees of the same age. Data are also given on the vertical distribution of the tannin and nontannins from the roots to branch tips, showing a gradual decrease of tannin toward the top of the tree.

The study of ferrochrome as a tanning material has been practically completed on a laboratory scale, as a result of which work public-service Patent No. 1,757,040 on ferrochrome tanning preparation and process has been issued.

LEATHER

Every year in this country shoes and other leather goods having a retail value of approximately \$2,000,000,000 are made. Values of such magnitude involving daily necessities of such widespread use provide a fertile field for scientific studies and for the application of technical knowledge directed toward the production of finished articles of greater serviceability and better workmanship; more efficient and less costly methods of production; judicious selection of

goods for the service intended; and their protective treatment and proper use for the longest service.

Assistance has been given several manufacturers of shoes and leather goods in indicating and eliminating the causes of defective products.

The results of an elaborate study of the density of leather have been published in *Industrial and Engineering Chemistry*.

Cooperation has been continued with the Government Printing Office in helping that office to select bookbinding leathers for public binding work. In this connection 47 leathers have been tested and analyzed during the year.

The last part of an 8-year natural aging experiment on the deterioration of leather is being completed. This experiment involves a comparison physically and chemically of the leathers before and after aging and will provide much original data that should be of intense interest and value regarding the deterioration of leather, and especially in establishing beyond question the extent of the absorption of acid from naturally polluted air.

FARM FABRICS

During the past year service tests were continued on hay caps made of lightweight fabrics and subjected to various waterproofing treatments. As a result, definite recommendations regarding materials and treatments suitable for this purpose can now be made.

Experiments were conducted to show the waterproofing value of new products, including chlorine derivatives of diphenyl and two water-insoluble and water-repellent substances extracted from apple peels by the food research division. One of the latter, ursolic acid, gave canvas very high water resistance, but was found to be subject to mildew under the conditions of the test. New commercial anti-septics were tested for their mildew-proofing value. Precipitation of salicylanilide and aluminum stearate together on the fabric offers considerable promise as a water-repellent and mildew-resistant treatment where it is desired to leave the appearance of the fabric unchanged.

From the studies conducted to determine the cause of the flame-proofing action of tin oxide it was found that certain other metallic oxides, including those of copper and manganese, are as effective as tin oxide and probably more so. Data bearing on the theory of the flame-proofing action of certain metallic oxides were obtained and are being prepared for publication.

Farmers' Bulletin 1157, entitled "Waterproofing and Mildew-proofing of Cotton Duck," was published in revised form. This bulletin tells how to select canvas for various uses on the farm and elsewhere, and gives formulas for waterproofing canvas with easily procurable materials.

PAPER

Work on paper testing and paper specifications, in collaboration with Government agencies and scientific societies, and work on the deterioration of paper has long engaged the attention of this bureau and was actively continued during the past year.

The United States Government uses paper in very large quantities, and the preparation of specifications for the various kinds of paper

needed, which was initiated by the Bureau of Chemistry more than 20 years ago and in which the Department of Agriculture has taken a leading part ever since, has resulted in estimated annual savings ranging from \$50,000 to \$500,000. Publishers of periodicals, by adopting similar specifications, have effected savings estimated at more than \$500,000 annually.

The paper technical committee of the Federal Specifications Board and the paper specifications committee of the Congressional Joint Committee on Printing have revised old and prepared new specifications for the purchase of paper by the General Supply Committee and the Government Printing Office. The American Chemical Society has also been given advice regarding the suitability of papers for their regular publications and also for the proposed library editions of their journals.

During the past year, in the studies of the causes of deterioration of paper, attention has been given to the improvement of methods of analysis, the development of an accelerated-aging test, the examination of old papers, and determining the effects of small quantities of aluminum sulphate, sulphuric acid, and hydrochloric acid on papers.

Previous work in this bureau had shown that there is a progressive loss of folding endurance with continued heating of papers. Continued work along this line during the past year showed that heating accelerates the injurious action of certain constituents of the paper, thus developing in a short time what might be the action of these constituents over a long period of time under normal conditions of room temperature. Such a test offers the best and simplest means now known for predetermining the intrinsic merits of papers from the standpoint of durability.

About 20 samples of old papers of different kinds were subjected to chemical and physical tests in an effort to determine the causes for different degrees of deterioration. The results showed very clearly that those papers having relatively high acidity also showed great deterioration.

The effects of aluminum sulphate, sulphuric acid, and hydrochloric acid were studied also by applying the heating test to samples of all-rag waterleaf paper of high strength, which had been treated with solution of these chemicals in various concentrations. The results so far obtained indicate that small quantities of the chemicals cause great deterioration of paper as measured by this test. The untreated sample showed no decrease in strength after heating for 72 hours at 100° C.

UTILIZATION OF CORNSTALKS

The purpose of the studies on the utilization of cornstalks is to determine the practicability of various suggested uses and to promote such uses as will aid in the control of the European corn borer. Particular attention was given to the utilization of cornstalks and other crop by-products by destructive distillation. Experimental runs were made on cornstalks, cottonseed hulls, and rice hulls in a wood distillation plant and also in a plant that had been used for the destructive distillation of straw but had been tentatively remodeled for use with other farm wastes. Valuable information was

acquired on the changes in design and equipment necessary for satisfactory results with cornstalks. The products obtained were also studied in the laboratory as an index to plant-operation factors and from the standpoint of possible commercial applications.

Samples of cornstalk flour and bagasse flour were prepared and furnished to a manufacturer for experimental use in plastics.

NAVAL STORES

Turpentine and rosin, the principal products of the naval-stores industry, are essential raw materials of many manufactures. They are produced at more than 1,400 plants scattered over the Southern States from North Carolina to Texas, and the annual production has a value at the stills of about \$60,000,000. The bureau's work on naval stores includes development and demonstration of improved practices, processes, and equipment so as to prevent waste, reduce cost of production, and yield products of better quality, and research on the composition and properties of naval stores to promote wider and more profitable means of utilization.

FIELD SERVICE

During the year the naval-stores technologist visited 34 plants, where he gave instructions and demonstrations to proprietors and a large number of visitors on improved methods of turpentine distillation, still setting, barrel gluing, rosin straining, and handling of products. The erection of 12 turpentine stills was supervised by the field representative. It was not possible to comply with all the requests for personal supervision in the erection of stills, and 32 persons were given advice through correspondence on still erection.

GUM CLEANING

Improvements were made in the experimental gum-cleaning equipment at Arlington Experiment Farm which allowed the filtration of turpentine gum on a practical scale. Two hundred and fifty gallons of crude gum were passed through a special type of filter, having but $1\frac{1}{4}$ square feet of filtration surface, in about four hours. Rosin made in the laboratory from the filtered gum was perfectly clean and brilliant. However, in the experimental work at Tallahassee, Fla., the rosin made contained small reddish-brown particles, even though the gum was filtered perfectly clean. It was found that these were caused by dissolved or dispersed matter in the water which is always present as an emulsion in crude gum. This dissolved matter separates in solid form and contaminates the rosin when the turpentine and water are distilled off. Various means of demulsification and separation of the water were studied, and a process was developed in the laboratory that gives promise of producing a filtered gum entirely water free, which, on distillation, will yield a brilliant dirt-free rosin. Special equipment will be necessary for the practical application of this process, and on the design of this equipment will depend the success of the process.

In connection with the gum-cleaning experiments at Tallahassee, considerable experimental work was done on the operation of a commercial still. In previous work with the steam still it had been ob-

served that the charge may be scorched by allowing the coils to become exposed. This was verified, but it was found that, with the use of superheated steam in coils kept under regulated temperature and pressure, the introduction of superheated steam mixed with moist steam into the charge as required, and having the charge cover the coils at all times, rosin could be obtained entirely free from scorching and burning. It was found possible to control the temperature of the charge within very narrow limits and to turn out the rosin at any temperature desired.

COMPOSITION OF OLEORESIN

In connection with the study of the composition of oleoresin, a substantial quantity of white crystalline mixed resin acids was prepared from a sample of scrape, and a quantity of mixed-resin acids was prepared from gum. A partial separation was made of pimarinic and sapinic acids. Numerous experiments were made with fractional crystallization of these acids in an attempt to isolate the pure component acids of the two classes. So far only preparations with an increased concentration of one or another of the various acids in the respective classes have been made.

COMPOSITION OF TURPENTINE

Considerable attention was given to the design, construction, and installation of laboratory-fractionating apparatus for use in separating the constituents of turpentine. Six fractionating columns of various types were installed. Five of these columns and accessory apparatus, including pressure regulators and dephlegmators, particularly for vacuum fractionation, were made in the bureau. Numerous experiments were performed with turpentine and other liquids to determine the relative merits of the various fractionating columns. Fractionations were made of a number of turpentines from authentic and commercial sources, and their composition in terms of alpha and beta pinene and tailings was determined. Two papers bearing on this work were presented before the spring meeting of the American Chemical Society.

Further work was done on a method for determining small quantities of sulphur and chlorine in turpentines, particularly sulphate wood turpentine, and a paper describing the method and giving results from its use was prepared for publication. In cooperation with the carbohydrate division a polariscope equipped with a monochrometer was set up, and optical rotation measurements on turpentines and other liquids can now be made at different wave lengths.

In cooperation with naval-stores producers and users, examinations and tests were made on 11 samples of turpentine to verify the accuracy of the hydrometers being used.

DETERIORATION OF TURPENTINE

The effect of continued storage of turpentine was studied in collaboration with a manufacturer of shoe polishes. The turpentine examined had been kept for about two and one-half years in large storage tanks under conditions suggested by this bureau, which included almost complete exclusion of air and frequent withdrawal of

separated water. At the end of this time the bulk of the turpentine was used in regular shoe-polish production and was considered satisfactory. Some of the turpentine from the large storage tanks was transferred to clean steel drums which had been shellacked on the inside. The storage of the water-free turpentine in these drums was continued for another year under conditions duplicating as nearly as possible those under which the turpentine was previously stored. Periodic laboratory tests indicated little change during the storage in tanks, but appreciable change on additional aging for one year in drums, which was probably caused by contact with air during the transfer. The turpentine was still considered satisfactory for use in shoe polish after the storage in drums.

Laboratory work was carried on to determine the effect on turpentine of shipment and storage in galvanized steel drums and in steel drums coated on the inside with various kinds of varnish and lacquer. Turpentine has a slow corrosive effect on galvanized sheet steel and becomes contaminated with zinc and iron. The only coating which has thus far been found to prevent satisfactorily an inter-reaction between iron and turpentine containing water is a special lacquer baked on the surface of the metal.

GLUING TURPENTINE BARRELS

Previous work having failed to develop an effective and economical substitute for glue, work during the past year consisted largely in encouraging the more general adoption of the improved gluing practice whereby freshly glued barrels are exposed to the action of formaldehyde vapors for 36 to 48 hours. The use of formaldehyde vapor was found to be more practical than rinsing out the glued barrels with 10 per cent formaldehyde solution, which is likely to leave water in the barrels.

TURPENTINE IN FRESH GUM

In order to acquire information on variations during the chipping season in the quantity and properties of turpentine in fresh gum from different varieties of pine and from trees of different ages and types of growth, experiments were conducted in cooperation with the Forest Service on 12 trees in the vicinity of Starke, Fla. These included six slash pines and six longleaf pines, representatives of the two varieties being paired as closely as possible with regard to size, condition, and exposure. Collections of gum were made at 2-week intervals and the samples of gum were analyzed and the typical constants determined immediately after each collection.

OIL, FAT, AND WAX INVESTIGATIONS

PALM OIL

In view of the rapid expansion of the palm-oil industry, a more intimate knowledge of the properties and composition of this oil has become desirable in connection with its utilization. Previous investigations have shown that differences exist in the composition of various commercial palm oils, and studies have been under way to determine the characteristics and the composition of samples of oil from the important producing localities. During the past year such

studies were made on palm oil from Nigeria. The Nigerian oil showed a higher saponification value than the oils from Sumatra and the Belgian Congo previously investigated. The determination of the proportions of the individual fatty acids in each sample closely agreed with the differences observed in saponification values and the quantity of saturated and unsaturated fatty acids.

SAPOTE-SEED OIL

An examination was made of the oil expressed from the fruit of the sapote, a member of the Sapotaceæ family grown in Honduras. This tree is commonly found in southern Mexico, Central America, Ecuador, Colombia, and other American tropical regions. In some localities considerable quantities of the seed are said to be available for the production of oil and cake. The oil can be used either for edible or technical purposes. An analysis of the seed showed that it contained 57 per cent of oil, and the oil was found to contain about 21 per cent of stearic acid. Since in the majority of the vegetable oils palmitic acid predominates in the saturated acid fraction, it has been suggested that sapote-seed oil could be used to advantage for obtaining stearic acid in quantity, the use of which is annually increasing at a rapid rate.

CHERRY OIL

Owing to the rapid expansion of the sour-cherry canning industry in this country in recent years attention is being given to the utilization of the separated pits. An investigation was made of the oil expressed from the pits, and it was concluded that this oil is well adapted for use as an edible oil, as well as for the manufacture of cosmetic preparations. Manufacturers of the oil have found that it is particularly suitable for use in the oil roasting of nuts to be salted.

WHEAT OIL

The study of the oil from wheat germs, concerning which there is little reliable information, has been undertaken in view of the fact that such information would be of much value to the packing industry and to those engaged in certain types of nutritional studies involving the use of wheat oil. The oil under investigation was obtained by extraction from an exceptionally good preparation of germ material prepared by a flour mill, especially for a study of the proteins. To date it has been possible only to determine its characteristics. As the keeping quality and stability of the oil are of interest also to the baking industry, it is proposed, from time to time, to examine reserve samples of the oil from this standpoint.

ANALYTICAL METHODS

Further study has been made on methods of analysis for the evaluation of cottonseed in connection with the department's committee on sampling and grading of commercial cottonseed, and several changes in procedure have been recommended. As the seeds, which are to be graded or evaluated on their chemical analysis, aggregate a total between 4,000,000 and 5,000,000 tons a year, the great importance, both

to the farmers and to the manufacturers of the products, of having an accurate analysis of the seed is obvious.

A preliminary study has been made of the preparation and physical properties of certain esters of the higher fatty acids to determine whether any of these derivatives could be used for the separation of one fatty acid from another.

Considerable work was done in attempting to convert quantitatively ordinary oleic acid, which is found in a great number of fats and oils, into the solid isomeric form, known as elaidic acid, by means of various catalysts, but so far it has only been possible, under the more favorable experimental conditions, to obtain a conversion of 80 per cent of the original oleic acid. Quantitative conversion would provide a much-needed method for the direct determination of oleic acid not only in various fats and oils but also in various manufactured products.

NUTRITIONAL INVESTIGATIONS

CHEMICAL INVESTIGATIONS ON PROTEINS

Because of the predominant and indispensable place proteins occupy not only in the group of proximate principles of foodstuffs but also in the life processes of every living cell, renewed interest and attention are being given to problems of chemical and nutritional significance that center in the knowledge of the proteins. The chemical structure and nature of proteins still remain largely unknown. Many unsolved problems of great importance depend for their solution on a more complete knowledge of protein chemistry.

PROTEINS OF CEREALS

Investigations on glutelins, a class of proteins, have been continued. The glutelins of wheat, rice, oats, corn, rye, and barley have previously been investigated in this bureau, and during the past year the glutelin of buckwheat was studied. Only one glutelin was found, which is characterized by having a high content of the nutritionally essential amino acids, arginine and lysine. It is apparently devoid of proline, an amino acid which has been found in practically all seed proteins. Its isoelectric point is characteristic of glutelins as a group.

SWEETPOTATOES

The proteins of sweetpotatoes are valuable supplements to the proteins of cereals and legume seed in that they contain nutritionally essential amino acids which are deficient in the proteins of cereals. During the past year studies have been made of the nature of the changes that take place in the proteins when sweetpotatoes are allowed to remain in storage under different conditions. Most of the protein in freshly dug sweetpotatoes, or in those that have been stored in a cool place, consists of a globulin to which the name ipomoein has been given. However, if sweetpotatoes are allowed to remain improperly stored in a warm place it has been found that the quantity of ipomoein gradually decreases, and there appears another protein which increases in quantity with the time of storage up to a certain limit. Ultimately both proteins gradually disappear with a corresponding increase in nonprotein nitrogen.

ALCOHOL-SOLUBLE MILK PROTEIN

Chemical studies were made on the alcohol-soluble protein from milk. This protein is unique in that it is the only protein obtained from an animal source which is soluble in alcohol, all alcohol-soluble proteins heretofore known having been obtained exclusively from cereals and grain. Quantities of this milk protein are available in a crude form in the alcoholic extract of casein obtained during the preparation of vitamin-free casein used in connection with nutritional feeding experiments. The product has been purified, and the percentages of some amino acids, not heretofore determined, have been established.

SOYBEANS

Work has been started to ascertain possible differences in the nature and chemical composition of the proteins of several widely different varieties of soybeans. Knowledge of any differences, for example, in the percentages of the nutritionally essential amino acids would have an important bearing in connection with the selection of the right varieties of soybeans for cultivation from the standpoint of their nutritive value.

SUGARCANE JUICE

An investigation is in progress to obtain more information regarding the character of the nitrogenous compounds in sugarcane juice by applying new methods of analyses which have recently been developed. This work should be of interest in connection with problems relating to the sugar-refining industry.

BIOLOGICAL INVESTIGATIONS OF PROTEINS AND VITAMINS

POTATO PROTEIN

With the object of ascertaining the nutritive value of potato protein, a preparation containing all the constituents of the potato except most of the starch and one-half of the washed pulp was fed to rats. When this preparation furnished the sole source of nitrogen in diet adequate with respect to the essential dietary factors other than protein, only maintenance resulted. Addition to the diet of as much as 20 per cent gelatin, either alone or together with a mixture of cystine, tyrosine, and tryptophane caused no improvement in the rate of growth. On the other hand, addition of 10 per cent casein or lactalbumin enabled the animals to grow at a normal rate. It is concluded that casein and lactalbumin contain some essential dietary factor which is lacking in the potato preparation and in gelatin, and which is not one of the known essential amino acids.

COTTONSEED MEAL

The investigations conducted on the nutritive value of cottonseed meal during the last few years have definitely established that the value of the meal for animal feeding is influenced by the method of manufacture. These investigations are being continued in order to determine which factors are operative and which factors must be carefully controlled to insure meals of the highest quality.

Information of importance in the interpretation of investigations concerning cottonseed-meal injury has been obtained during the past year. Gossypol, the recognized toxic principle occurring in the raw seed to which cottonseed-meal injury has been attributed, produces injury symptoms in the animal that are influenced to a marked degree by the quality and quantity of several essential components of the diet. If the level of gossypol fed to experimental animals is kept constant, the toxic response is greatly modified by varying the quality of the diet with respect to protein, fat, iron, and reaction of the inorganic residue. This is observed with rations which are adequate with respect to every known essential. In addition, certain products, such as yeast, have an apparent specific effect that can not be attributed to the quantity of protein, fat, or minerals carried by the yeast. It has been found possible to detoxify raw cottonseed containing an abundance of free gossypol by mere contact with certain solvents.

FISH OILS

The cooperative work with the Bureau of Fisheries on the nutritive value of fishery-food products and by-products has been confined largely to obtaining more complete information with respect to the vitamin content of fish oils. It has been shown that menhaden oil, which ordinarily is about three-fourths as potent in vitamin D as cod-liver oil, can be made fully as potent as that oil in vitamin D if the heat treatment in the preparation of the oil is properly controlled. Salmon oil, prepared from the waste that results in canning, can be made twice as potent as cod-liver oil in vitamin D and equal to high-grade medicinal cod-liver oil in vitamin A. While the present domestic output of salmon oil is not large, by using waste that is now discarded it can be made three times as large as the present domestic output of cod-liver oil. Canned salmon is an important source of vitamin D in the American diet. Statistics show that the canned salmon sold annually in this country contains more oil than the cod-liver oil used for both human and animal feeding. Tests conducted during the past year show that the oil from canned salmon is fully equal to cod-liver oil in vitamin D.

VITAMINS IN SULPHURED APRICOTS AND IN FROZEN ORANGE JUICE

Studies of the effect on vitamin C of sulphur dioxide used in the manufacture of dried apricots have shown that sulphured apricots retain their original vitamin C content remarkably well through commercial processing and subsequent storage, whereas dried unsulphured apricots are devoid of this vitamin. However, ordinary methods of cooking destroy the vitamin completely, and if the practice of sulphuring is to be of any practical significance in the preservation of vitamin C it will be necessary to devise other methods of preparing the fruit for the table.

Frozen orange juice has recently come on the market in large quantities. Orange juice is recognized as an important source of vitamin C, and there is at present no available data on the effect of different methods of freezing and storage of frozen juice on its vitamin content. Studies have been undertaken in cooperation with the food research division to obtain the desired information. Feeding tests

are now in progress on orange juice frozen under conditions simulating those used in the industry, and some of the material is being kept at a low temperature to determine the effect of storage.

COLOR AND FARM WASTE INVESTIGATIONS

DYE INTERMEDIATES

Vat dyes continue to be the most important factor in the domestic dye industry. Ranking first in order of production, they constituted 35 per cent of this country's total output of dyes in 1929. Though there was a marked decrease in importations of dyes in 1930, the total amount imported was still large, aggregating more than 1,700,000 pounds. The work of the bureau has an important influence in the field of vat-dye production, and the results of the studies of the various problems are looked forward to by the industries concerned. As carried on, these studies include determinations of physical constants of dye intermediates, a study of fundamental details of synthesis, improvement of existing methods, and the preparation of new vat-dye intermediates. This work points the way to new fields for the production of dyes to compete with those which are still imported.

The preparation of di-chloroanthraquinones from o-dichlorobenzene is being given active consideration. Combined with phthalic anhydride this material gives a mixture of two isomeric di-chloroanthraquinones, but unfortunately the more valuable of the two is present only in comparatively small amounts. Attempts to change this ratio have been unsuccessful, but as a result of the work done by the bureau much misinformation on the subject of these intermediates has been cleared up. The physical constituents of new compounds have been established, and general information of a practical character has been made available for future investigations. Work on the synthesis of 2-amino-anthraquinone from phthalic anhydride and bromo-benzene has been completed, and much information of a fundamental nature as well as of potential practical value is included in a report on this synthesis which has been prepared for publication.

BIOLOGICAL APPLICATION OF DYES

Stains bear somewhat the same relation to many biological researches that dyes bear to the textile industry. They have a wide application in the examination and differentiation of the various constituents of animal and plant life and are of utmost importance both for the advancement of pure science and for the application of science in matters of vital practical importance. The outstanding achievement of the research on stains during the past year has been the synthesis, in cooperation with the Garvan Cancer Research, of a new stain for cancer tissue, which is the best that has yet been devised for this purpose, and which has greatly simplified the work of the cancer diagnosticians.

A comprehensive study of the preparation of seven basic magentas by two methods has been practically completed. This work will be of great assistance to the stain technologists, who have been uncertain as to which one of the several dyes contained in the commercial mixture known as basic fuchsin was responsible for the results obtained

in their technics. These dyes have been carefully synthesized, and their identity is being proved by analyses and spectro-photometric tests. Samples will be forwarded to leading stain technicians for tests and reports on their relative values.

Various methods of preparation of auramine have been studied with a view to obtaining good yields and a pure material. This dye has a very strong antiseptic value and is used very extensively in bactericidal work.

Fifty-one samples of stains have been identified and analyzed during the past year from the commission on standardization of biological stains. The Garvan Cancer Research was supplied with a considerable number of special dye preparations. The Cancer Research of Philadelphia was supplied with several special neutral stains, with a number of preparations of fluorescent character, and with two antiseptic preparations of the addition-product type. Further absorption measurements were undertaken for the Rockefeller Institute, and considerable progress was made in preparing for the institute a reliable supply of cresyl blue.

INDUSTRIAL FERMENTATIONS

The chemical action of microorganisms is receiving attention both from a fundamental and a practical standpoint. Since work was started in the bureau on industrial fermentations some five years ago, the bureau has become recognized as one of the leading authorities on the subject and bureau contributions to the literature are being quoted in Japanese, German, and English journals.

A survey of the action of molds on xylose prepared from farm wastes has been practically completed for the genera *Aspergillus* and *Penicillium*. In all, 164 strains of these fungi have been investigated. While practically all these organisms utilize the xylose well for growth, very few produce compounds which might have industrial significance.

The great difficulty in the utilization of the metabolic activities of molds on an industrial scale is that, in fermentations involving oxidation reactions, the organisms must be grown on the surface of the solution. This requires the use of expensive shallow pans and gives rise to serious engineering problems. Any means that will allow such fermentations to be carried out in deep vats would be a very valuable contribution. This problem has been investigated, using the kojic acid fermentation because of its standard yields. Under ordinary cultural conditions submerged growth of the organisms gives very low yields of acid. This may be due to a number of causes, chief among which is the diminished available supply of oxygen.

To overcome this, experiments have been conducted in which the fermentation is carried on under increased air pressures. Thus far experiments at 5 and 10 pounds pressure have been completed. At 10 pounds the yield of kojic acid has been double that obtained at atmospheric pressure. It is planned to carry pressures up to 100 pounds, which would be entirely feasible in an industrial process, but before this is attempted additional details must be worked out.

The action of certain organisms on dextrose was investigated, using commercial corn sugar as the source of dextrose. The most

important finding was the ability of a strain of *Aspergillus flavus* to produce much higher yields of kojic acid than have hitherto been reported. A yield as high as 48 per cent of theory has been obtained. This yield makes the production of this material by fermentation feasible if sufficient demand for the product develops. About 50 samples of kojic acid have been distributed to those interested.

The stimulating effects of more than 30 organic compounds on mold metabolism have been investigated. One compound, ethylene chlorhydrin, has been found to be decidedly effective in increasing yields of kojic acid by about 25 per cent.

BAGASSE CELLULOSE

The work on bagasse cellulose during the past year has been devoted to taking up the final phases of the investigation and the preparation of a report on the work. Cellulose has been produced which is in many ways superior to some of the alpha cellulose produced from wood pulp. Although it is not so good as the cellulose produced from cotton linters, it would be acceptable in many cases in which the latter is now the sole raw material.

LIGNIN

Lignin is an important component of farm wastes and is also an industrial waste as part of the sulphite waste liquor of paper mills. There is no definite information available on the chemical composition of this material, and very few of its physical properties are known. These facts must be cleared up before any satisfactory procedure for its utilization can be contemplated. During the past year definite progress has been made in this respect, and certain compounds have been obtained which aid in a reasonable speculation as to the nature of the lignin molecule.

Studies have been made on the possible empirical industrial utilization of lignin. A number of resins have been formed by the combination of lignin with other materials, and a patent has been issued covering these products. Some work has also been started on the production of tanninlike materials from lignin sulphonic acid.

INSECTICIDE INVESTIGATIONS

INSECTICIDAL PLANTS

In the study of insecticidal plants with the object of developing new insecticides which can be substituted for lead arsenate, the compound rotenone has continued to claim the greatest share of attention, as it is still the most important and promising material in this connection.

Rotenone has been subjected to intensive study from four angles—structure, methods of application, toxicity to insects, and possible toxicity to humans and animals. Information has been obtained concerning the solubility in various liquids as a guide to the analysis of the roots of the tropical plants supplying rotenone and their commercial extraction; methods of preparing dusting and spraying mixtures containing rotenone have been studied, and important data

concerning its decomposition in solution discovered; its toxicity to many insects, such as aphids, caterpillars, codling-moth larvae, clothes moths, fleas, lice, and mites, has been investigated by collaborating entomologists; and a thorough study of its possible toxic effects to man and animals has been made by means of careful and numerous experiments on guinea pigs, rabbits, and dogs, to which it was administered intravenously, subcutaneously, and orally. As a short summary of the findings it may be said that rotenone has now proved itself superior to nicotine against many aphids, at least comparable with lead arsenate against some chewing insects, and practically nontoxic to man and animals when taken orally.

The other crystalline materials, toxicarol, deguelin, and tephrosin, that have been isolated from certain tropical plants, have also been intensively studied and their toxicities to numerous insects have been determined. Certain relationships which have been established between these materials are expected to prove a great aid in the final interpretation of the structure of this whole group of fish-poisoning materials.

An investigation of more than 50 other plants reputed to have insecticidal value, many of them native to the United States, is also under way.

SYNTHETIC ORGANIC INSECTICIDES

The results of insecticidal tests with 25 dipyriddy derivatives and related compounds, carried out in conjunction with the Bureau of Entomology, were published. This work brought out important information on the correlation between chemical structure and toxicity. New methods for the synthesis of nicotine isomers starting with gamma gamma dipyridyl have been worked out.

Certain organic thiocyanates and isothiocyanates were prepared, and their toxicity to fish was determined. The results indicate that these classes of compounds are promising sources of new insecticides, and tests of their toxicity to insects will be made.

SPRAY RESIDUES

The quantity of arsenic left on apples by various spray treatments and the efficacy of numerous washing solutions in removing it under different conditions were determined. The effect of sprinkler irrigation on the amount of arsenic residue was also studied, and it was found that low sprinklers have no effect, but that high ones playing on the foliage have a tendency to reduce it.

In continuing the work on arsenic residues on tobacco several hundred analyses were made and the residue per leaf was found to range from 0.12 to 3.52 milligrams of arsenic. The arsenic present at the time the leaves are picked persists through the sweating and curing processes. In the course of this work it was discovered that nicotine and certain other materials seriously interfere with the standard Gutzeit method of estimating arsenical residues.

FUMIGANTS

The use of hydrocyanic acid generated from sodium or calcium cyanide was studied in relation to the fumigation of narcissus bulbs. Certain relationships between dosage, hydrocyanic acid concentra-

tion, and degree of control were determined. The effect of absorption of hydrocyanic acid by the bulbs was very marked. A fundamental study of the reaction of the citrus red scale to fumigation with liquid hydrocyanic acid has been started in an effort to overcome the resistance to hydrocyanic acid that the red scale has developed during the long period in which fumigation of citrus trees has been practiced.

HOMOLOGUES OF PARIS GREEN

The study of the compounds that copper arsenite forms with the copper salts of the fatty acids has been continued in an effort to develop a material that is equal to Paris green in its toxicity and superior to it in other respects.

The lower members of the series, containing formic, propionic, and valeric acids, on some of which other investigators have worked, were first studied, and then some of the higher members containing oleic, lauric, palmitic, and stearic acids were prepared. For these combinations of which the copper salt of the fatty acid is insoluble a new method of analysis was developed for determining definitely whether the combinations formed are true double compounds or only mixtures of the fundamental components.

Stearic "green" was proved to be a definite substance, and the preparation of about 25 pounds of it was begun in order that both laboratory and field tests might be made during the coming season.

OIL EMULSIONS

Chemical work on oil emulsions was started at the New Orleans laboratory of the Bureau of Entomology to assist the entomologists in a fundamental study of the reaction of insects to oil emulsions.

A new method for the practically instantaneous preparation of soap-oil emulsions in the cold and without agitation was developed, and a manuscript describing it was submitted for publication.

Investigations were started on the use of copper oleate and the fatty acid salts of other toxic metals, such as mercury and zinc, in emulsions to increase their insecticidal action or confer on them fungicidal properties, and considerable work was done along this line. A definite procedure for the preparation of such emulsions was worked out for copper oleate and will be applied to salts of the other metals.

FLUORINE INSECTICIDES

The study of all compounds containing fluorine that have any significance as insecticides was continued. Results of tests against the codling moth in the Northwest were so favorable that a bulletin recommending the use of certain fluorine compounds for the control of this insect has been prepared by the entomologist in charge of these tests and the fluorine expert of this bureau.

DUST-EXPLOSION INVESTIGATIONS

The dust-explosion hazard exists in 28,000 industrial plants employing almost 1,500,000 persons and manufacturing products having an annual value of \$10,000,000,000. The Bureau of Chemistry and

Soils is the only governmental agency studying dust explosions in industrial plants and in agricultural operations, and it is looked to in both the United States and in foreign countries for technical information on the subject. The investigations relate directly to the development of methods and appliances for the saving of life, property, and foodstuffs. During the past year 18 dust explosions, which resulted in the death of 17 persons, injury to 53 others, and property damage amounting to \$562,750, were investigated. These explosions occurred in grain elevators, wood-working establishments, and plants manufacturing cattle feed, starch, linseed meal, tobacco by-products, and wood flour.

INERT GAS

In certain plants flue gas used to create an inert atmosphere has proved injurious either to the product or to the equipment in which it is used. During the past year conferences were held in Washington and in Chicago on the development of suitable gas-washing and gas-conditioning equipment. As a result of these conferences and previous tests of gas-conditioning equipment the wooden grid type scrubber is being recommended as the most economical and practical piece of equipment for the purpose.

Following an explosion of tobacco dust at a tobacco by-products plant the company officials asked for a survey and inspection of the plant for the purpose of eliminating dust-explosion hazards. The inspection indicated the practicability of using inert gas, and on the bureau's recommendation an inert-gas system has been designed and installed by the company.

VENTING AREA TESTS

Work has been under way at the Arlington Experiment Farm to determine the ratio between dust-explosion pressures and venting areas. In a heavily reinforced compartment or room with a volume of 100 cubic feet, explosions are produced with starch, flour, grain dust, cork, or other powdered combustible material, and observations are made to determine the value of vents of different types and sizes. Swinging iron vent doors of various sizes and hinged plain glass windows are provided to release explosion pressures and thus prevent the destruction of the chamber. By leaving vents of various sizes open, the effect of pressures within the box can be observed. These tests have attracted considerable attention and have been given publicity by newspaper writers, photographers, and motion-picture producers. A number of demonstrations have been given for officers of the Baltimore and Washington fire departments and for operators of industrial plants. Additional demonstrations are being scheduled.

SERVICE TESTING

Samples of dust submitted by firms in various sections of the country were tested for explosibility, and reports were prepared giving the information desired by the companies to allow them to take the necessary precautions against the dust-explosion hazard. The samples included wood flour, tobacco, processed tankage, wood, soap, resins, linseed-oil cake, and other dusts.

DUST-EXPLOSION HAZARDS COMMITTEE

In order to provide for the prompt application of the control and preventive methods developed by the bureau engineers, close cooperation has been maintained with industries, insurance organizations, State commissions, safety organizations, and numerous fire-fighting and fire-protection units.

At the annual meeting of the National Fire Protection Association at Toronto in May, 1931, the dust-explosion hazards committee, which is under the leadership of the chemical engineering division of the bureau, presented for adoption regulations for the prevention of dust explosions in wood-flour manufacturing establishments, in spice-grinding plants, terminal grain elevators, and starch factories; regulations for pulverizing systems for sugar and cocoa; and regulations for the use of inert gas for fire and explosion prevention.

STATE FIRE SCHOOLS

The chemical engineering division cooperated during the year with the national fire waste council of the United States Chamber of Commerce and with a number of State colleges and firemen's organizations in conducting short-course fire schools for the instruction of firemen. These schools were well attended, and considerable interest was manifested by the firemen in dust-explosion prevention. At these meetings addresses were given on suitable subjects, and dust-explosion demonstrations were produced in the miniature elevator. Requests have been received from a number of States for assistance during the coming year in conducting similar schools.

SPONTANEOUS IGNITION OF HAY

During the year experimental work on spontaneous heating of hay was continued in the specially-constructed barn on the Animal Husbandry Experiment Farm at Beltsville, Md.

The plan to use 25 or 30 tons of loose, undercured alfalfa could not be carried out because of the severe drought. It was therefore necessary to utilize baled alfalfa, shipped in from other sections. In July, 28 tons of alfalfa were placed in the barn after the bales had been opened. As the loose hay was thrown into the mow it was sprinkled with water, approximately 20 tons of water being added in this manner. Samples of hay and gases were collected at desired points during the progress of the experiment.

It was indicated in a general way in this experiment that the admission of measured quantities of air and of oxygen directly to heating areas (during certain stages, at least) did not produce a further rise in temperature, but that the indirect admission of air to such areas, infiltration through near-by vertical holes cut in the hay, was conducive to a rise in temperature. Although efforts to produce the advanced stages of heating were unsuccessful, the experiment was of value in yielding information on such factors as compactness and wetness of hay, indirect ventilation, effect of the injection of oxygen, and in perfecting technic and apparatus. The amount and nature of acids found in the samples of hay col-

lected during the progress of the experiment was determined by analysis. The samples of gases were also analyzed.

Apparatus designed for laboratory investigation of the oxygen-absorbing properties of various types of hay, before and after subjection to spontaneous heating, has been constructed.

COOPERATION WITH NATIONAL ORGANIZATIONS

The Bureau of Chemistry and Soils has leadership of the farm fire protection committee of the National Fire Protection Association. This committee includes 4 members from the Department of Agriculture, 1 member from the Department of Commerce, and 13 representatives of national organizations. At the request and under the supervision of this committee a farm-fire survey covering one county in each of the States of Iowa, Wisconsin, and Indiana was made during the summer of 1930, and a report of the survey has been published by the association.

Final editing and revision of the handbook, Prevention and Control of Farm Fires, has practically been completed. The preparation of this material was in the hands of a joint committee, comprised of members of the farm fire protection committee and of the agricultural committee of the national fire waste council.

The spontaneous heating and ignition committee of the National Fire Protection Association, which includes 3 representatives from the Department of Agriculture, 2 from the Department of Commerce, and 12 from national organizations, is preparing a national program of research and also a brochure on the spontaneous heating and ignition of agricultural and industrial products.

On the request of this committee questionnaires for reporting cases of spontaneous heating and ignition of agricultural products were sent out to all State fire marshals, directors of experiment stations, and directors of extension workers. The response as well as the interest shown has been gratifying, and a great deal of general information was forthcoming. This contact also provided a medium for further bringing the importance of the subject to the attention of these officials.

EXHIBITS

Exhibits to show the results of the bureau's research work, including subjects on food research, vitamins, farm wastes, dust explosions, and fertilizers, were prepared and displayed at State fairs, industrial expositions, and conventions.

Three exhibits were prepared and shipped to France for the International Exposition of Colonial and Overseas Possessions at Paris. One of these exhibits relates to the subject of bagasse, the second is made up of citrus by-products, and the third deals with the utilization of sweetpotatoes.

ENGINEERING DESIGN AND DEVELOPMENT SERVICE

The chemical engineering division renders special service to the various divisions in the bureau in the design, installation, and operation of mechanical equipment for the commercial application of scientific discoveries for the utilization of agricultural resources. The division cooperated with the industrial farm products division

in the development of a commercial process for filtering crude turpentine gum. A semicommercial plant was designed and constructed at Tallahassee, Fla., for the purpose of obtaining experimental data on the practicability of a turpentine gum-filtration process developed during the past year.

Plans and specifications were prepared on the design of a naval stores field laboratory. Economic engineering studies were made on the various processes proposed for the utilization of farm products.

EXPLOSION AND FIRE HAZARD OF INSECTICIDES

Considerable experimental work was carried on by the chemical engineering division in cooperation with the insecticide division to determine the explosion and fire hazards of insecticides. A series of explosibility tests were made with the vapors from liquid ethylene oxide mixed with liquid carbon dioxide; also liquid ethylene oxide and solid carbon dioxide. Similar tests were made with mixtures of carbon bisulphide and carbon tetrachloride saturated with sulphur dioxide and with mixtures of ethylene dichloride and carbon tetrachloride saturated with sulphur dioxide. Large-scale tests were conducted at the Norfolk, Va., grain elevator operated by the Norfolk & Western Railway Co. during the fumigation of wheat with ethylene oxide and solid carbon dioxide. The tests at this elevator and previous tests at the Canadian Pacific Railway grain elevator at Port McNicoll, Ontario, indicated that there is no apparent explosion or fire hazard in the storage bins after the grain has been treated with a fumigant consisting of 10 parts of solid carbon dioxide to 1 part of ethylene oxide.

The Bureau of Chemistry and Soils is cooperating with the National Fire Protection Association in the work of the fumigation hazards committee, which includes two representatives from the bureau. This committee is developing practical safety standards for application in the use of insecticides.

SOIL INVESTIGATIONS

SOIL SURVEY

The practical importance of the soil-survey work is not merely expressed in its value to the individual farmer but it constitutes the study of the most important of the natural resources of the United States and is not duplicated in any sense whatever by any other studies carried on by any other agency in the United States. It is a work that is exclusive, unique, and peculiar to itself.

The work of the soil survey is primarily directed to the investigations of soils in the field, their natural geographic environment as related to agriculture, identification of the various kinds or types of soil, and the preparation of reports in the form of descriptive material and maps on their character and distribution. During the fiscal year of 1931 work was done in 85 areas distributed over 30 States, Porto Rico, and the Virgin Islands.

Thirty-nine of these areas were completed during the year. Some of these projects were begun in the preceding year, and some were begun during the fiscal year of 1931 but have not been completed.

Most of this work was done in detail, the soil types being differentiated in as great detail as was possible so that they might be shown on a map with the scale of 1 inch to the mile. A relatively small area, however, was surveyed by the reconnaissance method, the most important project being a survey of practically the entire State of Vermont. Tables 1 and 2 show the details of areas covered and their distribution.

TABLE 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1931*

State or territory	Area	Area surveyed	
		Square miles	Acres
Alabama	Dallas County	1 451	288,640
	Lauderdale County	150	96,000
	Mobile County	1 117	74,880
	Wilcox County	330	211,200
Arizona	Winston County	56	35,840
	Tucson area	408	261,120
California	Alturas area	174	111,360
	Dixon area	435	278,400
Colorado	Suisun area	1 244	156,160
	Longmont area	1 500	320,000
Georgia	Decatur County	211	135,040
	Hall County	114	72,960
Idaho	McDuffie County	1 46	29,440
	Benewah County	1 425	272,000
Indiana	Jennings County	1 33	21,120
	Knox County	368	235,520
Iowa	Vermillion County	254	162,560
	Washington County	1 458	293,120
Kansas	Franklin County	157	100,480
	Hancock County	1 164	104,960
Kentucky	Monroe County	371	237,440
	Washington County	1 69	44,160
Louisiana	Bourbon County	486	311,040
	Kingman County	179	114,560
Maryland	Marion County	1 418	267,520
	Payette County	27	17,280
Michigan	Mercer County	1 127	81,280
	Livingston Parish	1 474	303,360
Minnesota	Kent County	1 227	145,280
	Queen Annes County	49	31,360
Mississippi	Bay County	246	157,440
	Eaton County	1 202	129,280
Montana	Iron County	1 679	434,560
	Montmorency County	1 386	247,040
Nebraska	Oscoda County	153	97,920
	Hubbard County	1 579	370,560
New Mexico	Greene County	332	212,480
	Marion County	104	66,560
New York	Gallatin Valley area	507	324,480
	Dundy County	263	168,320
North Carolina	Furnas County	1 629	402,560
	Harlan County	1 518	331,520
Ohio	Hitchcock County	724	463,360
	Knox County	1 175	112,000
Oklahoma	Sherman County	135	86,400
	Lovington area	354	226,560
Oregon	Delaware County	1 1,084	693,760
	Orleans County	27	17,280
Pennsylvania	Rensselaer County	77	49,280
	Steuben County	1 420	268,800
Rhode Island	Brunswick County	1 341	218,240
	Chatham County	203	129,920
South Carolina	Franklin County	1 418	267,520
	Surry County	33	21,120
Tennessee	Adams County	185	118,400
	Athens County	100	64,000
Texas	Licking County	1 153	97,920
	Putnam County	1 169	108,160
Vermont	Craig County	1 282	180,480
	Grant County	1 440	281,600
Washington	Kiowa County	1,062	679,680
	Pittsburg County	1 955	611,200
West Virginia	Tillman County	1 298	190,720
	Woodward County	73	46,720

¹ These figures do not include portions of these areas surveyed in preceding years.

TABLE 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1931—Continued*

State or territory	Area	Area surveyed	
		Square miles	Acres
Oregon.....	Umatilla County.....	¹ 422	270, 080
Pennsylvania.....	Indiana County.....	439	280, 960
Porto Rico.....	Soil survey of island.....	¹ 289	184, 960
South Carolina.....	Abbeville County.....	284	181, 760
	Dillon County.....	¹ 169	108, 160
	Bee County.....	293	187, 520
	Collin County.....	¹ 294	188, 160
Texas.....	Falls County.....	455	291, 200
	Polk County.....	¹ 149	95, 360
	Scurry County.....	¹ 795	508, 800
	Wheeler County.....	417	266, 880
	Grayson County.....	425	272, 000
Virginia.....	Nansemond County.....	271	173, 440
	Rockbridge County.....	¹ 414	264, 960
West Virginia.....	Pendleton County.....	¹ 408	261, 120
	Randolph County.....	215	137, 600
Wisconsin.....	Barron County.....	¹ 340	217, 600
	Crawford County.....	¹ 320	204, 800
Wyoming.....	Johnson County.....	¹ 1, 241	794, 240
	Sheridan County.....	¹ 1, 062	679, 680
Total.....		28, 530	18, 259, 200

¹ These figures do not include portions of these areas surveyed in preceding years.

TABLE 2.—*Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1931, and areas previously reported*

DETAILED

State or Territory	Work during 1931	Work previously reported	Total	
			Square miles	Acres
Alabama.....	1, 104	54, 036	55, 140	35 289, 600
Arizona.....	408	3, 537	3, 945	2, 524 800
Arkansas.....		15, 547	15, 547	9, 950, 080
California.....	853	31, 666	32, 519	20, 812, 160
Colorado.....	500	4, 905	5, 405	3, 459, 200
Connecticut.....		1, 704	1, 704	1, 090, 560
Delaware.....		2, 276	2, 276	1, 456, 640
Florida.....		15, 160	15, 160	9, 702, 400
Georgia.....	371	34, 866	35, 237	22, 551, 680
Idaho.....	425	11, 075	11, 500	7, 360, 000
Illinois.....		6, 770	6, 770	4, 332, 800
Indiana.....	1, 113	18, 174	19, 287	12, 343, 680
Iowa.....	761	45, 815	46, 576	29, 808, 640
Kansas.....	1, 083	13, 902	14, 985	9, 590, 400
Kentucky.....	154	5, 146	5, 300	3, 392, 000
Louisiana.....	474	16, 957	17, 431	11, 155, 840
Maine.....		2, 197	2, 197	1, 406, 080
Maryland.....	276	13, 367	13, 643	8, 731, 520
Massachusetts.....		8, 811	8, 811	5, 639, 040
Michigan.....	1, 666	26, 030	27, 696	17, 725, 440
Minnesota.....	579	¹ 10, 341	10, 920	6, 988, 800
Mississippi.....	436	29, 495	29, 931	19, 155, 840
Missouri.....		37, 177	37, 177	23, 793, 280
Montana.....	507	2, 013	2, 520	1, 612, 800
Nebraska.....	2, 444	53, 849	56, 293	36, 027, 520
Nevada.....		652	652	417, 280
New Hampshire.....		1, 411	1, 411	903, 040
New Jersey.....		9, 895	9, 895	6, 332, 800
New Mexico.....	354	1, 084	1, 438	920, 320
New York.....	1, 608	26, 572	28, 180	18, 035, 200
North Carolina.....	995	43, 379	44, 374	28, 399, 360
North Dakota.....		16, 878	16, 878	10, 801, 920

¹ Kittson, Norman, and Wilkin Counties, Minn., were included in the detailed work and recorded in the report for 1930. In this report and hereafter they will be included in the reconnaissance work of the Red River Valley.

TABLE B.—Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1931, and areas previously reported—Continued

DETAILED—Continued

State or Territory	Work during 1931	Work previously reported	Total	
	Square miles	Square miles	Square miles	Acres
Ohio.....	607	16, 189	16, 796	10, 749, 440
Oklahoma.....	3, 110	7, 758	10, 868	6, 955, 520
Oregon.....	422	14, 579	15, 001	9, 600, 640
Pennsylvania.....	439	18, 260	18, 699	11, 967, 360
Porto Rico.....	289	860	1, 149	735, 360
Rhode Island.....		1, 085	1, 085	694, 400
South Carolina.....	453	24, 764	25, 217	16, 138, 880
South Dakota.....		8, 286	8, 286	5, 303, 040
Tennessee.....		11, 198	11, 198	7, 166, 720
Texas.....	2, 403	54, 527	56, 930	36, 435, 200
Utah.....		2, 419	2, 419	1, 548, 160
Vermont.....		1, 175	1, 175	752, 000
Virginia.....	1, 110	10, 125	11, 235	7, 190, 400
Washington.....		10, 752	10, 752	6, 881, 280
West Virginia.....	623	21, 335	21, 958	14, 053, 120
Wisconsin.....	660	25, 867	26, 527	16, 977, 280
Wyoming.....	2, 203	2, 818	5, 121	3, 277, 440
Total.....	28, 530	796, 684	825, 214	528, 136, 960

RECONNAISSANCE

Alaska.....		31, 915	31, 915	20, 425, 600
Arkansas-Missouri.....		58, 000	58, 000	37, 120, 000
California.....		32, 135	32, 135	20, 566, 400
Kansas.....		39, 960	39, 960	25, 574, 400
Michigan.....		1, 322	1, 322	846, 080
Minnesota.....	1, 960	3, 877	5, 837	3, 735, 680
Montana.....	3, 730	38, 527	42, 257	27, 044, 480
Nebraska.....		53, 064	53, 064	33, 960, 960
North Dakota.....		39, 240	39, 240	25, 113, 600
Ohio.....		41, 420	41, 420	26, 508, 800
Oklahoma.....	2, 515	1, 164	3, 679	2, 354, 560
Pennsylvania.....		41, 405	41, 405	26, 499, 200
South Dakota.....		41, 400	41, 400	26, 496, 000
Texas.....		152, 855	152, 855	97, 827, 200
Vermont.....	5, 809	3, 315	9, 124	5, 839, 360
Washington.....		16, 540	16, 540	10, 585, 600
Wisconsin.....		14, 425	14, 425	9, 232, 000
Total.....	14, 014	610, 564	624, 578	399, 729, 920

During the past year a soil survey was made on the island of St. Croix (Virgin Islands). This will be published as a separate report, and the soil types will probably not be included in the list of types covering regular detailed surveys.

The number of soil-survey reports sent to the printer during the past year was greater than for many years. Notwithstanding the depression in agriculture, the results of the soil survey are much more in demand than ever before.

One of the important results of the agricultural crisis now prevailing in the United States will doubtless be increasing demand for land classification. Without discussing the meaning or method of land classification, it should be mentioned here that the soil survey furnishes the only logical foundation on which a land classification for agricultural purposes can be based.

A classification of land on the basis of the soil is far more complete for agricultural purposes than a classification on any other possible

basis, because the soil is the one factor involved in agriculture that expresses the combined results of all factors of geographic environment on which agriculture is dependent.

The agricultural crisis will make necessary a final adjustment of agriculture to the best lands. The knowledge being accumulated by the soil survey will be of the greatest possible assistance in making these adjustments that are so important and essential to the future development of our agricultural industry.

EXTENSION OF SOIL SURVEY TO FOREST LANDS

Up to the present time the soil survey has been concerned with agricultural lands whose characteristics made cultivation possible. The increasing adjustment of agriculture to the more productive agricultural lands and the inevitable future use of much land which has previously been in cultivation for the growth of forests and grass, not merely because of the necessity for timber and grass products but also for the purpose of conserving water and protecting the soil from erosion, makes it desirable to know the character of all the soils, and whether they can best be cultivated or devoted to forestry and pasturage. During the past year the bureau has extended its work into mountainous areas and into the areas of the national forests to a greater extent than ever before. It does not undertake to study the character of the soils in these areas in detail, but every soil map that covers the national forests will in the future cover the general character of the soils within the forests and mountainous areas not within national forests. By this method can be determined the distribution of the areas where different kinds of timber or different species of grasses may be grown most successfully.

PEAT INVESTIGATIONS

Closely allied to the work of the soil survey is that of peat investigations. The object of peat investigations is to study the origin, development, and characteristics of peat and muck land in order to determine the relative value of these resources for different uses and to apply the information gathered in the classification and mapping of these organic materials.

During the course of the last fiscal year a detailed survey and classification of peat soils in the Erie-Ontario Basin and other areas of New York State was carried out in cooperation with the agricultural experiment station of Cornell University. As a result of this field work, 3 principal series of organic soils and 12 type profiles have been established and described. The report discusses certain ecological and morphological interrelations existing between structural profile features and factors of climate, edaphic conditions, and the succession of vegetation stages in the past that brought about a peat deposit. The study of these peat areas provides not only a basis for uniformity and completeness of profile studies and for further special investigations of physical properties, chemical organic compounds, and crop responses, but it also suggests means of turning unprofitable, submarginal peat land to commercial uses other than farming.

Further progress in coordinating the research of the bureau on the physical and chemical character of organic soils has been facilitated by recently developed field methods establishing type-profile units. The investigation of complete type profiles, obtained from different geographic sections of this country, with attention to botanical composition, sequence, thickness, and characteristic features of different layers of parent material in the entire cross section, is especially important. The full utilization of results of such work aids in establishing the geographic relationships of these units.

Much progress has been made in the comparison and correlation of profile data, but the information is still far from being complete. The United States, together with Alaska and other territorial possessions, affords striking examples of natural regions of peat land. The major divisions recently established are receiving further study in order to establish the principal subdivisions and their respective units. A characterization of the subgroups and units furnishes an opportunity for verifying their relationships to Eurasian peat lands.

The work in peat investigations and its service is steadily expanding. Experimental work on uses of peat is now being developed at the Arlington Experiment Farm in cooperation with the greens section of the United States Golf Association and the Bureau of Plant Industry. A circular has recently been prepared giving information as to the character of moss peat, its characteristic properties, relative merits for different uses, and distribution in this country.

The peat deposits of the United States are assuming industrial and commercial importance sufficient to warrant the collection and the publication of information as to the occurrence and geographic distribution of commercially important areas of peat, methods in the preparation of satisfactory peat composts, and the steps necessary to be taken in the development of an American peat industry that would yield products of commercial value comparable to peat products imported from other countries.

SUPPLEMENTARY WORK BY THE SOIL SURVEY

In addition to the work of field investigations of soils and the preparation of maps and reports, the soil survey undertakes other work based mainly on the accumulated results of the previous work. During the fiscal year 1931 a number of these supplementary or subordinate projects have been carried out to successful conclusion.

THE ATLAS OF AMERICAN AGRICULTURE

One of the most important activities consisted in the preparation for publication of the soils number of the Agricultural Atlas of the United States, data for which has been in the course of preparation for publication for several years past by the various bureaus of the department under the editorship of O. E. Baker, of the Bureau of Agricultural Economics. This material has now been assembled, the maps and illustrations have been prepared for the engraver, and a report is being prepared for publication. This number of the atlas will include a generalized soil map of the United States on the scale of 40 miles to the inch, covering 12 sheets. It will include various

colored and other illustrations and will be accompanied by a report describing the predominant soils of the United States and containing a discussion of their chemical composition based on the complete ultimate chemical analyses of the soil types.

LOCATION OF HOSPITAL FARMS

During the past year the Public Health Service has been engaged in the work of locating a number of sites for the establishment of hospitals to care for narcotic addicts. Because the hospitals are to be established on farms, the soil survey was called on to assist in their location. In deciding on the sites for two of these farms that have already been located, the character of the soil has been a factor of major importance.

LAND CLASSIFICATION IN THE LOWER MISSISSIPPI REGION

The War Department during the past year called on the Department of Agriculture for assistance in determining the character of the land in the lower Mississippi alluvial plain, on which it is designed to establish certain outlet channels for flood waters. The character of the soil was recognized as an important factor in the determination of the value of these lands. Employees of the soil survey assigned to this work have recently completed their first assignment, and a report has been submitted to the War Department. Work on additional areas is still in progress.

The results of this work and supplementary studies on the character of this region based on accumulated knowledge have emphasized the great fundamental value of lands in this region and the fact that the lower Mississippi flood plain of alluvial land constitutes one of the unique regions of the world, since there is no other region of similar character, size, and relative importance known. It is much larger than the alluvial land of the Nile, of the Amazon, of the Euphrates, and apparently than the alluvial area formed by any other large river, with the possible exception of the Ganges. It differs from the latter, however, in that it is a region which requires no irrigation. The Mississippi soils have been derived to a great extent from materials washed from the Great Plains of the West, where the soils have not only not been leached but where they also contain high percentages of organic matter, a considerable part of which has been deposited in the alluvium now accumulated in the Mississippi River bottoms. The region also is important because its climate makes possible the growth of almost any of the staple crops which man requires in large quantities. A still more important characteristic of the region is its contrast with the surrounding uplands, since it constitutes a very large area of extremely fertile soil in the midst of an area in which the upland soils are very poor. It constitutes, therefore, a tremendous reserve for the growth of grain for a large region where cheap grain production is not yet feasible. The recognition of the character, relationships, and importance of this region is regarded as one of the important results obtained in the work of the soil survey during the past year.

LAND CLASSIFICATION FOR THE INDIAN SERVICE

During the past year studies of the character of soils on the Pima Indian Reservation of Arizona were undertaken at the request of the Bureau of Indian Affairs. A considerable area of land of this reservation was found to be highly charged with alkali, and on the basis of this finding the projected utilization of the land has been decidedly modified.

PIPE CORROSION STUDIES

The Bureau of Standards is engaged in a study of the corrosion of iron pipes buried in the soil, and has asked assistance from the soil survey in studies of the character of soils in which pipes have been buried for experimental purposes and those in which commercial pipe lines have suffered severe corrosion. During the last year studies have been made in various places, chiefly in Oklahoma. This work consists of the identification of the soil in the spots where the pipes have been buried and a study of the particular horizon in which the pipes are embedded.

BOTTOM-LAND INVESTIGATIONS

During the past year considerable interest has been aroused, chiefly through the efforts of the Missouri Agricultural College, in the study of the characteristics and possible utilization of the alluvial land in various parts of the United States. This work has begun with compilation by the bureau of the areas and a study of the general character of the alluvial lands in the United States as shown in the reports of the soil survey. The study has also included an estimate of the area and character of the alluvial land in areas not yet covered by the soil survey based on the alluvial land in the near-by areas that have been surveyed. This compilation has reached an advanced stage, and very little additional work is required for its completion. It will furnish the basis for working out the details of a project or series of projects under the general direction of an interbureau committee recently appointed to give consideration to this matter.

THE NATIONAL MONUMENT AT YORKTOWN, VA.

At the request of the Interior Department the bureau has made a study of the character of the soils on the area of the National Monument Park at Yorktown, Va. A soil survey was made of the area of the park, and a report has been prepared for the use of the national park officials.

THE NATIONAL TRAINING SCHOOL FOR BOYS

The National Training School for Boys, situated in the vicinity of Washington, recently requested the bureau to make a soil survey of its farm area and give advice regarding the extension of agriculture and protection from erosion. The field work for this has been completed, and a report is now in the course of preparation.

VIRGIN ISLANDS

The decrease in the price of sugar and of bay rum has brought a crisis to the agricultural industry of the Virgin Islands. On the transfer of the administration of the islands from the Navy Department to the Department of the Interior, a request was made for a study of the natural conditions of the islands with a view to a readjustment of its agriculture. There are no mineral deposits on the islands, and the population is rather dense, so that their livelihood must necessarily be based mainly on agriculture. At the request of the Office of Experiment Stations a representative of the soil survey was detailed to make a general study of the soils of the islands. During the summer a representative of this bureau spent some time on the island of St. Croix, that part of the islands which was once important agriculturally and on which the present agricultural opportunities seem greatest. The results of this study have been prepared in the form of a soil map and a report describing the characteristics of the soils which show that the soils of the island are, in general, highly productive and that the readjustment of agriculture is a matter that concerns the willingness of the people rather than any limitation placed on readjustment by nature. A report on this work is being prepared for publication as a contribution from the soil survey.

MISCELLANEOUS

A large amount of miscellaneous correspondence has been carried on by the various employees of the soil survey during the past year, chiefly in answering questions concerning the character of soils in various parts of the United States and their utilization for special purposes.

SOIL-EROSION INVESTIGATIONS

During the fiscal year the work of the Bureau of Chemistry and Soils in connection with soil-erosion and moisture-conservation investigations was expanded by the establishment of three additional experiment stations. These new stations have been located in three major soil regions where erosion is a very serious agricultural problem, as follows: One near Pullman, Wash., in the Washington-Oregon-Idaho wheat belt; one 10 miles west of Statesville, N. C., in the middle Piedmont region, representative of upper South Carolina, middle North Carolina, and southern Virginia; and the third between Clarinda and Shenandoah, Iowa, representative of the rich loessial soil region of the Missouri River Valley. This expansion conforms to the provisions of the national program for erosion control and moisture conservation, as presented to Congress in November, 1928.

The work at the five previously established stations (at Guthrie, Okla.; Temple, Tex.; Hays, Kans.; Tyler, Tex.; and Bethany, Mo.) has proceeded with very gratifying results. Additional experiments have been installed and others planned, as funds have become available. Invaluable data, based on quantitative measurements of soil and water losses under various controlled conditions, relating to soil type, slope, character of rainfall, etc., are being accumulated. This fun-

damental information, now being obtained for the first time in history, is making it possible to interpret the basic principles of erosion, run-off, and water penetration with sufficient clearness for practical application of the results in connection with intelligent planning, installing, and perfecting erosion-control and water-conservation methods of both the engineering and agronomic types. It has been learned, for example, that the rate of soil removal on some types of land, occupying moderately steep slopes, is so rapid that there seems, at the present stage of the investigations, little possibility of saving such land where used for clean-tilled crops, except under systems of strip farming, supplemented by terracing, or terracing supplemented by soil-saving crops grown in rotation with the clean-tilled crops. These methods are now under experimentation. It is believed that these methods applied to erosion control will not only prove effective for the important soils in question and probably others, but that they will also be so practical and obviously sensible that farmers will readily adopt them. Strip subsoiling, also under experimentation, is a promising means of soil and water conservation; but this method will need to be subjected to several years' trial, under varying rainfall and soil conditions before it can be advocated as a practical farm method. The indications are that the system may work best on soils in comparatively dry climates. Subsoiling of entire fields is under way and may prove effective both as a practical means for reducing erosion and for increasing water storage in those soils having subsoils which fracture readily and do not run together again with saturating rains. Additional time will be required to test the practical efficacy of this method.

At the Guthrie erosion station the effectiveness of substantially built graded terraces has been demonstrated on the rolling parts of the red plains of Oklahoma not only in markedly slowing down erosion but in rehabilitating erosion-denuded land. In 1930 fairly good crops, considering the drought, were grown on terraced land which, before the time this farm was taken over for an erosion experiment station, had been cultivated and then abandoned because of excessive erosion. On the other hand, indications from experiments thus far carried out point to the impracticability of employing closed, level terraces on the Vernon fine sandy soil as far east as Guthrie, Okla. With this means of erosion control, under central Oklahoma conditions, strips of the ordinary farm crops are drowned out in the terrace channels. Open, level terraces, however, have held well and are very promising in connection with erosion control and the storage of rainfall in regions corresponding to central Oklahoma.

A very valuable experiment in connection with the renewal of fertility in severely eroded fields, which, though abandoned, have not yet been destroyed, is now under way at the Bethany (Mo.) erosion station on the important Shelby loam soil. A field of formerly good soil, which had suffered so much from sheet erosion and shallow gullying that it was considered of little value for crop production, has been overhauled at very low cost by constructing a series of small dams in the gullies by the use of old fertilizer sacks filled with soil and bluegrass roots, plowing in the gullies between the dams, and then seeding the area to wheat. The bluegrass roots went through

the bags, promptly took hold of the ground, and quickly established firm "living" dams, and these quickly silted in from above with the first rains. The wheat developed splendidly, and it is believed that with the rotation planned for the area erosion can be largely or entirely controlled on such areas by this comparatively inexpensive method. This experiment is so practical and cheap that it has attracted much attention of the farmers of the region, some of whom already are applying the experiment-station method to their fields. Another experiment of the same type, supplemented by terraces, is under way at the Tyler (Tex.) station and is being planned for installation at some of the other stations.

The effect of erosion on cotton has brought out some valuable information at the Guthrie erosion station. Here eroded land, having no topsoil, not only is losing its exposed subsoil material twice as fast as uneroded land of the same original type (having the same slope and rainfall and receiving precisely the same treatment), but it has thus far produced less than half as much cotton. Moreover, the staple of cotton from the eroded land is shorter than of that from the uneroded area, and the content of oil in the seed is considerably less. The acreage rate of cottonseed-oil production has been 38 pounds from eroded soil as compared with 98 pounds from uneroded soil of precisely the same original type.

A very important study at the Guthrie station has thrown new light on the function and importance of forest litter and leaf mold. Two adjoining plots of virgin post oak-blackjack woodland were put under control, both having the same soil, slope, and vegetative cover. One was left as nature established it; the other was burned over. During the nine months since this experiment was started the unburned land has lost water by run-off (rains have been infrequent thus far) at the rate of 338 gallons an acre, as against 28,250 gallons an acre lost from the burned plot. Only a trace of soil was washed off the area still having its cover of forest litter and leaf mold, whereas a considerable amount was lost from the burned-over ground. In other words, the burned-over land has lost water by run-off during the life of the experiment at the rate of nearly 100 tons an acre in excess of the run-off from the unburned land plus the water-holding capacity of its unburned litter and forest-mold cover. This would indicate that when the forest ground cover is burned muddy water is allowed to enter and clog up the pore spaces of the soil, thus enormously reducing the water-absorbing capacity of the ground.

These results are of the utmost importance in that they furnish a much clearer understanding of the function of forest litter, forest mold, grass litter, or any similar material of a protective-cover character. The discovery points to a number of possibilities for vegetative erosion control.

At the Kansas station an experiment to determine the possibilities of growing alfalfa in the uplands of western Kansas and Nebraska through the increased storage of rain water in the soil, with the assistance of closed terraces, is indicative of successful results. Further trials will be necessary, however, in order to cover the necessary annual variations of rainfall before final conclusions are reached.

RECONNAISSANCE EROSION SURVEYS

A reconnaissance erosion survey of the Brazos River, Tex., drainage basin, carried on in cooperation with the Brazos River Conservation and Reclamation Commission and the Texas Agricultural Experiment Station, was completed during the field season of 1930, and a report covering this survey is awaiting publication of the latest census data pertaining to Texas agriculture, in order to correlate the latest crop statistics with the areas of the various types of erosion found. This survey covered all or parts of 70 counties, embracing a watershed area of 27,114,240 acres. Of a cultivated area within the boundaries of the watershed, amounting to 9,483,807 acres, 8,175,328 acres were found to be suffering from sheet erosion and gullying. Of the latter class, there were 1,894,951 acres, with 40,490 acres abandoned largely because of gullying. In addition, there are 17,630,433 acres of uncultivated land, of which about 4,712,654 acres are gullied and 741,893 acres consist of rough broken land and rough stony land. A considerable part of this gullied area represents land which has been severely eroded by reason of overgrazing. Some of it consists of formerly cultivated land abandoned because of erosion.

The results of this survey indicate that floods in the Brazos River probably can never be adequately controlled until a far-reaching, effective system of soil and water conservation is put into operation over the drainage basin. More than this, the survey shows the distribution of the critically suffering areas and defines the type of erosion going on under each classification. Such information is vitally necessary for a comprehensive analysis of the needs of the area and its various component parts in connection with the problems of flood control, irrigation, and soil conservation.

The measurements of the annual losses of soil by erosion are showing that the more productive part of the land, the humus-charged topsoil, is being washed off at a rate which is rapidly lowering the crop-producing capacity of numerous important farm soils, thus adding to the area of marginal and submarginal land. Moreover, the information being obtained is bringing about a better understanding of the durability or lack of durability of our important farming soils. This knowledge will unquestionably serve to bring the users of land to a realization of the absolute necessity for better protection of all erosive cultivated areas. This new conception of the vital importance of the topsoil is based on the fact that within periods ranging from 30 to 75 years unless better protection against erosion is provided, the entire depth of the more fertile top layer of many exceedingly important types of farm land will be washed off down to the subsoil, which is not only much less productive (in many instances practically valueless), but which is much more difficult to till and much more susceptible to destructive gully washing.

Extensive field work by the bureau has clearly demonstrated that the topsoil of most farm lands is not nearly so deep as generally has been supposed. Of 172 soil samples, representing 115 important types of farm land (nearly all of them erosive uplands), collected from 34 States, only 7 samples were as thick as 16 inches. The average depth of the topsoil represented by the 172 samples was only 9 inches. Some of these soils are being washed away at the rate of 7

inches—which in some instances exceeds the total depth of the topsoil—in about 30 years, and others at the rate of 7 inches in 35, 40, or 50 years, and so on. In losing this important layer, which not only contains the bulk of the soil humus and beneficial organisms but, undoubtedly, a considerably larger amount of available plant food than the unweathered, raw subsoil, it is obvious that the farmer on this land is losing his principal capital.

This is a new conception of land value, and it is being rapidly brought to the attention of the American farmer as the result of the experiments now being made to solve the fundamental principles pertaining to erosion processes and to ascertain practical methods for erosion control. The measurements of the rates of run-off and erosion, as well as the rates of fertility losses, for various slopes undergoing various cultural and cropping systems, on different soils, are supplying indispensable data for measuring the effectiveness of terraces on various slopes and soils. The results are providing data, for example, which determine the rate of soil loss between the various obstructions employed to control erosion, as terraces, crop strips, etc. With this information it will be possible to fix definitely the degree of slope for different soil types at which cultivation must cease and the land be turned over to forestry or a permanent grass cover.

SOIL-SAVING CULTIVATOR

At the Hays (Kans.) erosion station, the representative of the Bureau of Chemistry and Soils, with the cooperation of the Fort Hays substation, has built a cultural implement which promises to prove effective in that region and possibly in other regions by causing more of the rainfall to sink into the ground, thereby reducing erosion. This machine, which has attracted much attention, can be used both as a cultivator for row crops and as a surface-tillage implement for fallow. The important feature about it is a set of alternating shovels which work up and down so that with the forward motion of the machine the shovels scoop out dirt and leave holes in the ground. The excavations thus made alternate with piles of dirt, dropped between each pair of adjacent holes. The surface condition produced when the machine is run up and down the hill should be as effective in conserving water as that produced when operating along the contours. As now constructed, the machine leaves approximately 10,000 holes to the acre, each hole having a capacity ranging from 2 to 3 gallons of water. Although the holes collectively impound a large amount of water, their greatest value comes from the fact that the water is held still and given a chance to soak into the ground. Furrows, such as accelerate run-off, are not produced. When the holes are filled with water the overflow must escape by zigzagging around the piles of dirt. This results in slowing down the rate of flow and in increasing the amount of soil-absorbed rain water.

A set of regular cultivator shovels precede the digging shovels and can be used in case the latter do not destroy all the weeds. The digging shovels destroy the furrows of the cultivator shovels. This implement is still in the experimental stage. A machine of this

kind is needed and should find a very worth-while place in the exceedingly important problem of erosion control and moisture conservation.

EDUCATIONAL PROGRAM

More and more interest is being aroused in this great national problem. The educational side of the soil and water conservation program is being carried on as effectively as possible. The extension agencies of the Nation are taking hold of the problem in a determined way. They are carrying erosion-control information direct to the farmers as rapidly as it becomes available. Soil-saving campaigns are being put on in regions where until recently there was little or no interest in the matter.

The various erosion experiment stations are attracting much attention on the part of the farmers, agricultural colleges, high schools, vocational schools, county agents, bankers, insurance companies, implement manufacturers, and railroad officials of the regions affected. Frequent visitors are coming to the stations and are being shown the various experiments in detail. A recent field meeting held at the Bethany (Mo.) station was attended by hundreds of farmers, bankers, teachers, county agents, and others. Twenty-six Missouri counties and 20 Iowa counties were represented.

SOIL-FERTILITY INVESTIGATIONS

COTTON SOIL-FERTILITY STUDIES

The experiments with cotton on ratio of inorganic and synthetic nitrogen to organic nitrogen of vegetable and animal waste origin have shown that best results are obtained with fertilizers containing the nitrogen in ratio of about 80 per cent inorganic or synthetic to 20 per cent organic. This result is strikingly shown in experiments on Cecil clay loam at Youngsville, N. C., and is in general harmony with the results of experiments conducted by several State experiment stations on many soil types in the South. These investigations have been extended cooperatively with the North Carolina Agricultural Experiment Station in experiments on Ruston sandy loam at Fayetteville, N. C.

Three years' results have been secured in cooperative experiments with the Georgia Agricultural Experiment Station on the fertilizer requirements of Norfolk sandy loam at Waynesboro, on Orangeburg sandy loam at Fort Valley, on Carnegie sandy loam at Cuthbert, on Cecil clay loam at Yatesville, and one year's results on Clarksville silt loam at Adairsville. The experiment on each soil type includes plots in five replications and will be continued five years on the same plots. The results thus far secured, which have a practical and scientific value, show varying fertilizer requirements for the different soil types.

POTATO SOIL-FERTILITY AND FERTILIZER INVESTIGATIONS

Cooperative soil-fertility and fertilizer studies of the past year on potatoes in Maine, New York, New Jersey, Pennsylvania, Michigan, Ohio, and Virginia cover factors influencing the growth, composition, quality, and yield of potatoes when grown on prominent

soil types. The yield studies in 1931 were conducted in cooperation with agricultural experiment stations and leading potato growers. The soil-fertility and fertilizer investigations on potatoes continue to furnish results of practical benefit to the \$400,000,000 potato industry.

The results obtained during the fiscal year have continued to furnish information with respect to the proper ratio of nitrogen, phosphoric acid, and potash for use in potato production on prominent soil types; the kind and amount of nitrogen materials to employ; the kind and amount of potash materials to use in fertilizer mixtures; the amount of phosphoric acid necessary for optimum production; and the most economical rate of application of fertilizer for potatoes on prominent soil types. In the commercial potato-growing regions close contact was maintained with potato growers and their organizations, meetings were held in various sections, and the work was explained to the growers.

Soil-fertility and fertilizer investigations covering the influence of fertilizer composition and ratio on the shape, quality, and yield of potatoes were completed. This work was conducted cooperatively by the Bureau of Chemistry and Soils and the New Jersey Agricultural Experiment Station. A further coordinated field and laboratory investigation conducted by the Maine and New Jersey stations and the Bureau of Chemistry and Soils along similar lines has been completed, and the results are being assembled for publication.

The effect of different potash salts on starch, protein, and total solids content of potato tubers has been continued and results of interest obtained.

A study to determine the influence of ordinary strength and concentrated fertilizers on fresh-cut and suberized potato seed stock, conducted cooperatively by the Bureaus of Chemistry and Soils and Plant Industry was terminated during 1931. The data obtained indicate clearly the advantage of suberization. Better germination was secured with suberized stock, and the yields were proportionately better. The significance of the results is evident when it is considered that more and more highly soluble chemical salts are being used in fertilizer mixtures, thereby necessitating greater care in the application of modern fertilizer mixtures, particularly on our light soils. Cooperative investigations were established in 1931 with the Michigan, New Jersey, and Ohio stations to study the comparative effectiveness of a number of methods of placement of fertilizer on potato germination, stand, and yield. Through such an investigation it is expected that results of practical importance to potato growers will be obtained.

SUGAR BEET SOIL-FERTILITY INVESTIGATIONS

During the past year, permanent field headquarters for soil-fertility and fertilizer studies with sugar beets have been established at Scottsbluff, Nebr., and at St. Paul, Minn.

Under a cooperative agreement with the Nebraska Agricultural Experiment Station, a tract of land was acquired by the latter for a cooperative fertilizer-rotation experiment with sugar beets, barley, corn, and potatoes. The purpose of the experiment is to study the residual effect on other crops of fertilizers applied to sugar beets.

In addition to the above experiments, other fertilizer experiments with sugar beets are in progress at Sterling, Colo., and at Mitchell, Nebr., on the Scottsbluff substation.

A series of fertilizer experiments on sugar beets to test the response from different types of soil, using the same mixture on each, were located as follows: Kanawha, Iowa; Hector, Georgetown, Winthrop, Gaylor, and Bird Island, Minn.; and Grand Forks, N. Dak.

Crops from two cooperative fertilizer experiments with the Division of Western Irrigation Agriculture of the Bureau of Plant Industry, located at Huntley, Mont., and Newell, S. Dak., were harvested and reports submitted to the two cooperating offices. It is expected that, with the three years' results available this fall, the data will be submitted for publication during the fiscal year 1932. Other experiments with sugar beets harvested in 1931 included two fields at Kanawha, Iowa, and one at Chaska, Minn.

Five complete triangle fertilizer experiments in cooperation with the Bureau of Plant Industry were conducted at Oxnard, Calif.; Twin Falls, Idaho; Fort Collins and Rocky Ford, Colo.; and Saginaw, Mich.

Increases in tonnage from 2 to 7 tons an acre were obtained with phosphate alone, which is apparently the controlling element in sugar-beet fertilization, but there is an apparent wide difference in the results from different soil types. Experiments are now in progress to study this phase of the problem.

STRAWBERRY SOIL-FERTILITY INVESTIGATIONS

Seven field experiments with strawberries are being conducted in cooperation with growers. These are located in the Chadbourn, N. C., district on the Norfolk, Coxville, and Dunbar soil types. A cooperative experiment with the Bureau of Plant Industry is in progress on the North Carolina Coastal Plain Experiment Station at Wallace.

It has been the general practice in the Chadbourn district to use about 1,500 pounds an acre of a well-balanced commercial fertilizer annually, in two applications—one in late summer and the second in late winter. The experimental work has shown that yields are greatly increased when all the fertilizers are applied in late summer or early fall. Fifteen hundred pounds an acre of fertilizer applied in late summer increased the acre yield from 400 to 500 quarts of berries more than split applications of fertilizers, that is, one-half in summer and one-half in winter. The berries also matured earlier. This change in time of applying fertilizers resulted in an increased profit of \$75 an acre this season, as berries sold from \$5.50 to \$7.30 per 32-quart crate.

Experiments planned to determine the best ratio of nitrogen, phosphoric acid, and potash to use in growing berries have shown that mixtures containing from 4 to 6 per cent nitrogen have given best results and most profit. One important effect of potash this season was to increase the firmness and keeping quality of the berries to such an extent that they kept much better when stored or hauled than did berries grown without potash. Muriate of potash and sulphate of potash have had about the same comparative effects.

SOIL-FERTILITY INVESTIGATIONS WITH SUGARCANE

The soil-fertility and fertilizer investigations with sugarcane included both field and laboratory studies. Separate reports covering the accomplishments for the year were submitted for the two sub-projects, one of which will appear in the near future as a joint bulletin of the Louisiana Agricultural Experiment Station and the Bureau of Chemistry and Soils. The report of field investigations includes a complete description of the main soil series as determined by a reconnaissance survey of the entire sugarcane belt of Louisiana. The individual soil types on which the various fertilizer experiments were placed are also described in detail. The results of experiments showed very definitely that although nitrogen is the controlling factor, on certain soil types the best results are to be expected from a better-balanced ration of all three fertilizer elements.

The soils of the sugarcane belt have been grouped as follows: (1) Mississippi alluvium, terrace soils; (2) Mississippi alluvium, first bottom soils; (3) Red River sediments; (4) Mississippi-Red River sediments; and (5) coastal-prairie sediment of the Gulf coastal plain.

First-year results were also obtained from a series of experiments to determine the various rates of application and sources of nitrogen, including ammonium sulphate, cyanamid, cal-nitro, calurea, and sodium nitrate. From the one year's results only slight differences were obtained from the different sources of nitrogen, and an application of about 40 pounds of nitrogen to the acre appeared to give the most profitable results. Soil studies to determine the soil reaction most favorable to sugarcane production were continued at intervals throughout the year.

Samples of juice milled from the cane grown on the various fertilizer plots were collected and analyzed to determine if possible the effect on the juice of the application of different fertilizer mixtures such as are included in the five triangle experiments of 21 different mixtures each. A report on this work is being prepared.

A complete set of representative samples of the main soil types of the sugarcane belt is being collected at the Houma laboratories, and it is expected that the analytical work on these samples will be completed during the coming year.

Within the past year studies have been undertaken of different chemical and biological methods designed to hasten the decomposition of bagasse and other cane waste.

CONCENTRATED-FERTILIZER EXPERIMENTS ON PROMINENT SOIL TYPES (NORTHERN STATES)

During the past year further results of importance were obtained showing the crop-producing and economic value of concentrated fertilizers. The close experimental contact made possible between farmers and their organizations has served to bring to their attention the economies to be effected through the use of concentrated fertilizers, such as savings on mixing, bags, freight, hauling, and handling. In Aroostook County, Me., for example, the short growing season makes the use of high-analysis fertilizers particularly appropriate. The results obtained there by the Bureau of Chemistry and

Soils during 1931 and preceding seasons have done much to guide potato growers in the selection of fertilizers and to assure them that the use of fertilizers was warranted. A report of the cooperative results was issued by the Maine Agricultural Experiment Station. The results obtained with concentrated fertilizers during the year emphasize the necessity of exercising the utmost precaution in the use of concentrated fertilizer mixtures on the lighter, sandier soil types. Continued research is essential on such soils, especially that pertaining to the distribution and placement of concentrated fertilizers. Evidence is abundant that the promiscuous use of high-analysis fertilizers on light soils has been followed by retarded germination, broken stand, and reduced yields. It is on such soils that the importance of proper distribution and placement of concentrated fertilizers is becoming more evident.

Other crops used as indicator plants in the 1931 field work have been corn, wheat, Lima beans, string beans, peas, sugar corn, sweet-potatoes, and tomatoes.

The greater purity of synthetic fertilizer salts makes it imperative that a greater volume of investigational work be established, particularly on leachy soils. Results obtained during the year have indicated that, on such soils where systematic rotations are not practiced, the continued use of the relatively pure fertilizer salt mixtures may create serious deficiencies of minor elements like manganese, boron, copper, iodine, and similar elements.

Studies of this kind are in progress in New Jersey, but up to this time no appreciable curtailment of yield, regardless of the composition of the fertilizer, has been noticed.

CONCENTRATED-FERTILIZER EXPERIMENTS ON PROMINENT SOIL TYPES (SOUTHERN STATES)

Experiments with concentrated fertilizers are in progress in the Southern States in North Carolina, South Carolina, Georgia, and Florida. The field work is conducted partly in direct cooperation with farmers, and partly on State farms, cooperatively with State experiment stations. The investigations with concentrated fertilizers are concerned with a study of methods and time of application in order that this class of fertilizers may be used to best advantage, and with a view to supplying deficient essential elements which may not be contained in the pure salt concentrated fertilizers and which may be essential for successful crop growth on certain deficient soils.

Experiments with cotton have been in progress and are being continued on Cecil clay loam at Raleigh, N. C.; on Norfolk sandy loam at Holland, Va.; and on Norfolk deep sand at Pontiac, S. C., cooperatively with the experiment stations of these States. A study of time and method of application is being made in these experiments. Concentrated fertilizers, as compared with ordinary so-called low-analysis fertilizer, have caused a slight delay in germination of seed and frequently in poor stands, especially when the fertilizers are placed in contact with the seed or under the seed. There is less interference with seed germination when the fertilizers are placed to the side of the seed or applied about 10 days before planting and well mixed in the soil. The accumulation of soluble salts in the topmost 2 inches of soil, the region of seed placement, was greater with the use of concentrated fertilizers than with ordinary fertilizers. The

effect on yield has been to decrease it below that of ordinary fertilizers, especially when used on the same plots year after year on the coastal-plain soils.

The possible result of concentrated fertilizers failing to supply all the essential nutrients is being investigated in experiments with cotton on Norfolk sandy loam at Goldsboro, N. C.; on Cecil clay loam at Newton, N. C.; and Cecil sandy loam at Experiment, Ga.; with sweetpotatoes on Norfolk fine loamy sand in Currituck County, N. C.; and on tomatoes, truck crops, and citrus fruits in Florida.

The addition of calcium, magnesium, and a number of the heavy metals, such as nickel, copper, zinc, and manganese, to concentrated fertilizers has been to increase crop yields on most soils worked with. The yields of cotton in the North Carolina and Georgia experiments and of tomatoes in Florida have not been so large from concentrated fertilizers as from ordinary fertilizers. With the addition of some or all of these chemicals to concentrated fertilizers, the yields increased and were as large or larger than when ordinary fertilizers were used.

COTTON ROOT-ROT INVESTIGATIONS

The program of field fertilizer experiments on the relation of fertilizers and soil-fertility factors to cotton root rot, inaugurated in Texas in 1929 and 1930, is being conducted along the same general lines. There has, however, been some expansion in number and size of fields, in order to provide for comparative trials of new fertilizers, more comprehensive tests of phosphate sources and particle size of new fertilizers, experiments leading to a more practical and economical system of fertilizer usage, and extension of tests on the effects of subsoiling and deep tillage. New experiments were made of combined planting and fertilizer distribution, using a standard 2-row planter, which is important in respect to the development of a practical fertilizer usage for the black-land cotton root-rot region.

Seventeen field fertilizer experiments are being conducted in co-operation with farmers. These are located in nine counties in the black-land belt of Texas. In addition to these, cooperative experiments are in progress at substation No. 5, a branch station of the Texas Agricultural Experiment Station. Cooperative field experiments with the Bureau of Plant Industry are in progress at the United States cotton-breeding station at Greenville, Tex., and at the United States field station at San Antonio.

In general, consistent and significant increases in yield have been obtained from applications of fertilizer mixtures containing combinations of phosphate and nitrogen. In some instances the response was predominantly to phosphate, in some others nitrogen was predominant in effect. In most cases the increases were profitable from an economic standpoint, and in most cases they were of such magnitude as to offset losses due to root rot. The more highly phosphatic fertilizers led to a marked acceleration of maturity. This effect is of such a degree as to constitute a very promising means of evading losses from root rot. Certain of the newer concentrated fertilizers containing combinations of phosphate and nitrogen are particularly effective. The increase in yield of cotton and the acceleration of maturity resulting from the use of appropriate

fertilizers may constitute an effective means of offsetting and evading losses due to root rot.

Late-summer subsoiling in conjunction with a rotation crop is highly successful in reducing root-rot infestation. In an experiment on root-rot infested Houston clay, a section subsoiled in late summer and returned to cotton the following year, only 1.5 per cent of the plants succumbed to root rot, whereas 27 per cent of the plants on a nonsubsoiled section died. The cotton on the subsoiled area showed superior plant growth and produced a very appreciably heavier yield than on the control area. As a means of direct control of cotton root rot, midsummer subsoiling in conjunction with a non-cotton rotation crop appears very promising. Growers in general, and cooperators in particular, have been greatly impressed by the favorable effects of subsoiling and chiseling as a means of controlling cotton root rot. The use of phosphate fertilizer on subsoiled land has resulted in profitable increase in cotton yield.

Complete chemical analyses have been made of a large number of samples representing the common variations of the principal soil types of the black-land region of central Texas. The data yield important information on the fundamental character of the several soils. In most instances heavily infested areas are calcareous and alkaline, whereas noncalcareous soils of neutral and slightly acid reaction are much less subject to infestation or are entirely free of the disease. Soils low in soluble phosphoric acid are conducive to cotton root rot. Cotton root rot is minimized on soils containing an appreciable quantity of water-soluble phosphoric acid. Readily available phosphoric acid applied to cotton root-rot infested soils hastens maturity and increases the yield of the crop.

FERTILIZER INVESTIGATIONS WITH PECANS

Field experiments are in progress in some of the principal pecan sections of the South to study soil and fertilizer factors which influence tree growth, nut yield, and quality of the pecan. The field offices are maintained in conjunction with divisions of the Bureau of Plant Industry and the Bureau of Entomology, which are working cooperatively on pecan problems.

Four field experiments in progress in the Albany, Ga., section are located on some of the principal soil types used for pecans, including Norfolk deep sand, Bladen fine sandy loam, Greenville sandy loam, Orangeburg sandy loam, Norfolk sandy loam, Elkton silt loam, Miller loam, Lintonia loam, and Ruston fine sandy loam. These experiments have shown that nitrogen is the most important fertilizer element for tree growth and yield of nuts, but that phosphate and potash are also required for best results. When leguminous cover crops are grown for green manure, some nitrogen is supplied. Fertilizers containing from 4 to 6 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 3 to 4 per cent potash have given good results on most soils of the southeastern pecan belt. The fertilizer problems of many of these soils are complex and are being studied to determine the most suitable time to apply fertilizers, the relation of fertilizers to cover crops, and other features of the pecan industry.

Chemical work in progress in well-equipped laboratories at Albany and Shreveport is expected to throw much light on the problems

under study, including (1) chemical changes in soils as a result of the use of fertilizers of varying composition and the use of different green-manure crops, (2) the relation of soil type, soil composition, and soil moisture to pecan production and nut quality, and (3) the influence of fertilizer on the filling and eating qualities of the pecan.

FERTILIZER INVESTIGATIONS WITH SWEETPOTATOES AND POTATOES

The fertilizer investigations with sweetpotatoes and potatoes in North Carolina are being continued. Experiments which have been conducted for four years are in progress with potatoes on Bladen fine sandy loam at Aurora, N. C. The year's results are in harmony with those obtained in the three preceding years, showing that a fertilizer containing 5 per cent nitrogen, 7 per cent phosphoric acid, and 4 per cent potash gives larger yields than other fertilizers that have been analyzed, and that 2,000 pounds an acre is the most profitable quantity to use. The results also show that the source of nitrogen in the fertilizer mixture is important. Fertilizer having its nitrogen derived 80 per cent from mineral or synthetic sources and 20 per cent from organic sources of vegetable or animal waste origin has given best results.

Fertilizer studies with sweetpotatoes, which have been in progress for several years on Norfolk loamy fine sand in Currituck County, N. C., are being continued on concentrated fertilizers, sources of nitrogen, sources of potash, and placement and time of applying fertilizers.

Low-grade potash materials, such as manure salts and kainit, when used in fertilizers with superphosphate and nitrogen caused damage to young potato sprouts, resulting in a great loss. In the bureau's experiments with fertilizers containing mineral or synthetic nitrogen as source of nitrogen, or kainit as source of potash, the accumulation of water-soluble salts around the roots of the young plants during the first three weeks was high, and the salt concentration correlated with the percentage of plants dying in the plots. The investigations further show that fertilizers can be used with less injury to potato sprouts if applied to the side of the potato row, or if applied either broadcast over the top of the row or as a side dressing about two weeks after the plants have been transplanted and after they have developed a root system.

A report is in course of preparation for publication, giving the results of fertilizer experiments with sweetpotatoes on Norfolk loamy fine sand in Currituck County, on Portsmouth fine sandy loam in Craven County, on Norfolk sandy loam in Carteret County, and on Cecil sandy loam in Catawba County.

This project is cooperative with the agronomy division of the North Carolina Agricultural Experiment Station.

INVESTIGATIONS WITH PEACHES

An experiment to study the winter injury to peaches, as influenced by fertilizers, green-manure cover crops, and tillage operations, at Experiment, Ga., cooperative with the Georgia Agricultural Experiment Station, is in progress. Analysis of peach-tree twigs for stored

plant nutrients in fall, midwinter, and early spring is being made, with the thought of correlating fertilizer practice, green-manure usage, and tillage operations with growth factors and winter killing of trees. The analytical work was begun in 1931 on trees fertilized differently since 1929. The experiment is planned to study factors causing loss of peach trees by winter injury.

INVESTIGATIONS WITH CITRUS AND TRUCK CROPS

Nineteen field fertilizer experiments with truck crops inaugurated in Florida in 1930 were continued in 1931. Experiments are in progress in the principal trucking sections of the State, including Alachua, Brevard, Dade, Hillsborough, Indian River, Orange, Manatee, St. Lucie, St. Johns, and Seminole Counties, with cabbage, celery, beans, lettuce, peas, peppers, potatoes, strawberries, and tomatoes. Some of the experiments are located on State branch experiment stations and some on farms in cooperation with growers.

Fertilizers containing quickly available nitrogen salts of inorganic or synthetic origin have given best results on such truck crops as cabbage, lettuce, beans, and garden peas. Where the nitrogen contained in the fertilizer was principally from organic materials the crops developed slowly and were late in maturing. An application of low-grade organic-nitrogen material before planting followed by the use of quickly available nitrogen during the growth period brought best results. On many crops, especially celery, the use of physiologically acid fertilizer, such as urea and ammonium sulphate, was unfavorable, unless the soil was well limed prior to planting. Other soils, more acid in reaction, have given better results with fertilizers containing sodium nitrate. On certain truck soils, where strawberries and peas were grown, concentrated fertilizers, composed of pure salt chemicals, when fortified by the addition of traces of manganese, zinc, copper, nickel, and borax, have given more vigorous plants and larger yields than did the concentrated fertilizers or old-line fertilizers.

On the calcareous glade soils of Dade County, Fla., concentrated fertilizers gave reduced yields of tomatoes, as compared to yields from fertilizers made from superphosphate, potash salts, sodium nitrate, ammonium sulphate, tankage, and fish scrap. The addition of manganese to concentrated mixtures increased yields appreciably. The addition of copper, zinc, nickel, and manganese gave relatively larger increases which greatly exceeded the yield from pure salt-concentrated fertilizer or from old-line fertilizers.

Experiments are in progress with citrus fruits to study the effects of manganese sulphate on tree growth, leaf chlorosis, fruit production, and fruit quality. On some soils, especially those having a slightly acid or alkaline reaction, the addition of manganese sulphate improved the vigor of the tree, the character of the foliage, and the size and quality of the fruit. The results are sufficiently promising to justify an extension of this line of investigation with citrus-fruit soils, and well-planned experiments are being inaugurated with rare essential chemicals and concentrated fertilizers in groves located on four distinct soil types. In these experiments concentrated fertilizers

have given good results as to tree growth and fruit yields. There are some indications, however, that the quality of the fruit and the percentage of juice it contains are not so desirable as when fruit is grown with old-line fertilizers.

GREENHOUSE SOIL-FERTILITY INVESTIGATIONS

The greenhouse investigational work during 1931^{*} included a study of the influence of different phosphorus carriers on the growth and yield of lettuce, sugar beets, millet, wheat, rye, and grain sorghum. In general, it was found that the response to the phosphorus carriers was directly proportional to the availability of the phosphorus. In some instances, however, interesting departures occurred. For example, sugar beets responded markedly under greenhouse conditions to the less soluble phosphates. If the same response occurs in some of the sugar-beet growing sections of the West, the results will be an economic advantage to phosphate producers and consumers.

Studies with two natural potash carriers, alunite and polyhalite, in comparison with sulphate of potash have given indications that they possess a fair degree of availability in their natural state. These tests were conducted on oats and wheat and will be continued on other crops.

New work was started in 1931 in an attempt to determine the relative value of synthetic and natural sodium nitrate on the growth of certain vegetable crops. This greenhouse research involves primarily the question of appraising the value of uncommon elements.

A considerable volume of service and routine work was accomplished for other divisions and bureaus of the department, such as lime requirement, nitrate, moisture, and other determinations, as well as carrying on pot studies in the greenhouse.

COOPERATIVE SOIL-FERTILITY INVESTIGATIONS

The work of the Bureau of Chemistry and Soils on the cooperative project with the Bureau of Dairy Industry, Bureau of Plant Industry, and the South Carolina Agricultural Experiment Station has continued at the Sandhill experiment station. Chemical studies are made of changes in soil and the character of soil organic matter as a result of various green-manure crops in experiments conducted by the division of forage crops and diseases of the Bureau of Plant Industry. During the year several thousand chemical determinations were made.

Green-manure fertilizer experiments indicate that the addition of commercial fertilizers in the growing of cotton and corn in the sands of the station is essential. The use of a commercial fertilizer containing a high percentage of nitrogen (6 per cent), in conjunction with the turning under of stubble from a previous green-manure crop, has given larger yields than the use of a fertilizer containing a low percentage of nitrogen (2 per cent) in conjunction with the turning under of stubble and all vegetative matter of a previous green-manure crop.^{*} This result has an important economic bearing on the cropping system of the sand-hill region.

A system of 24 lysimeter tanks is being installed to supplement field plots in a study of fertilizer and green-manure problems pertaining to the building up of the soils of the sand-hill region. It is believed that more exact and reliable data can be obtained, which will contribute to solving these problems in a shorter period.

PLACEMENT OF FERTILIZERS

A comparison of methods of applying fertilizers to cotton has been under investigation in South Carolina in cooperative experiments conducted by the Bureau of Chemistry and Soils, the Bureau of Public Roads, the South Carolina Agricultural Experiment Station, and the National Fertilizer Association.

Greatest yields were obtained with the fertilizer placed closest to the seed, when injury to germination was not serious. The distance between seed and fertilizer for best results was shown to depend on factors such as character and moisture content of the soil and climatic conditions. The placement of fertilizers in relation to the seed has become important since fertilizers have undergone a change in composition in regard to their content of quickly soluble salts. Results from these studies have been helpful in obtaining good stands of cotton in regions where large quantities of fertilizers are required for cotton production.

Owing to the demand of fertilizer manufacturers, potato growers, and their organizations, field studies were started in 1931, in cooperation with the New Jersey, Ohio, and Michigan Agricultural Experiment Stations to compare different methods of fertilizer placement for potatoes.

SOIL CHEMISTRY AND PHYSICS INVESTIGATIONS

In connection with the laboratory investigations of the physical properties of the soils from the erosion experiment stations, laboratory studies are in progress to determine the maximum field moisture-carrying capacity of the horizons of each soil profile, with a view to a correlation of this property with field data.

Much fundamental data is being accumulated regarding the physical and chemical character of soils which erode badly. Results obtained and published in 1930 describe determinations that are particularly valuable in evaluating the erosional characteristics of soils. These, as well as complete mechanical and chemical analyses, are being carried out on samples from soil profiles of each of the erosion stations. As soon as field data are accumulated at the erosion stations, correlation will be made with the laboratory results. In connection with erosion investigations a study was made of field percolation rates. The results of this investigation, which have been recently published, show that percolation in the field is governed to a much greater extent by holes, cracks, and crevices, irrespective of origin, than by the mechanical composition of the soil. The capacity of the soil to disperse in water and to fill such cracks is the most important factor in regulating the rate of water percolation through soils. A soil auger was devised suitable for taking cores of undisturbed soil from the field for use in this investigation.

Work has been carried almost to completion on soil colloids as semipermeable membranes. This work has an important bearing

on moisture conditions in the soil. The results to date show a general relationship between the osmotic pressure developed with soil colloids as membranes and the major chemical constituents of the colloids.

Studies of the mineralogical composition of soils from various series indicate that the mineralogical composition of soils may vary to a considerable extent without materially affecting the classification of the soil by the soil-survey method. Work on soil colloids is being continued. One phase of the work, which is nearing completion, deals with the fractionation of colloidal material from different soil groups and shows that from many soils successive fractions of colloid may be approximately constant in character, whereas others may be effectually fractionated into groups of widely differing chemical characters.

The research on the causes of infertility of certain soils has had to do particularly with soils of high magnesium content. This work is nearing completion and will be published soon.

An investigation of the physical and chemical characteristics of certain American peat profiles has been completed and the results published. This work shows that the chemical composition of peats is greatly influenced both by the character of vegetation from which the peats have been derived and by the climatic conditions which prevailed during their formation.

Experiments are in progress with a view to ascertaining the value of certain peats as ingredients of fertilizer from the standpoint of their decomposition and the availability of the nitrogen. Experiments just completed and submitted for publication show that the base-holding power of peats and particularly of peat colloids is relatively high, suggesting the probability of a beneficial effect from this standpoint when they are added to soils, especially those which have been greatly weathered and leached. Investigations in progress show that peat colloids and colloidal materials from other organic sources possess high and varying absorbing power for water and for plant-food materials. Knowledge of the specific properties of such materials should aid in the selection of those best suited for top-dressings of sod and for special cultural purposes.

It has long been known that phosphatic fertilizers are much more efficacious on certain soils than on others. An investigation under way shows that the colloidal materials of soils differing in character are quite unlike in their effect on the assimilation of phosphorus by plants. Progress is being made in correlating this effect with the chemical character of the soil colloids and thereby giving a basis for predicting something of the degree of beneficial action which might be expected from applications of phosphatic materials. A study is also being made of soil treatments that will increase the efficiencies of phosphatic fertilizers.

Tests of the new method of dispersing soil material by means of supersonic waves have been completed and the results submitted for publication. It was found that dispersion could be obtained more readily than by conventional physical methods, but that even with the aid of the powerful supersonic waves complete dispersion in some cases could be obtained only after very prolonged treatment.

In several instances this division has assisted in carrying out research projects which are being pursued primarily by other divi-

sions of the bureau. One of these, dealing with the physical and chemical composition of finely divided natural phosphates, has been completed. The pipette method developed for the mechanical analysis of soils has been successfully applied to natural phosphate materials. Some relation has been found between phosphoric-acid content and specific gravity in the case of natural phosphates. Samples with high phosphoric-acid content have higher specific gravities than the lower-grade materials. Another project nearing completion involves a crystallographic examination of various mixtures of concentrated fertilizers. The results to date show that in most cases of mixed fertilizer ingredients a much shortened microscopic examination is entirely adequate to identify the chemical compounds present.

The routine physical and chemical analyses of the division included approximately 600 mechanical analyses and 500 chemical examinations and analyses. About 80 of these involved chemical determinations of all constituents present. Many of these examinations were made for the soil survey, soil erosion, and smelter fumes investigations, as well as for other divisions of this bureau. Others were made for the Forest Service, Bureau of Public Roads, Bureau of Plant Industry, and for other Government departments.

SOIL MICROBIOLOGY INVESTIGATIONS

The division of soil microbiology has continued to follow two general lines of work: (1) The investigation of the legume nodule organisms as an adjunct to crop growing, together with the inspection of cultures offered for sale for this purpose, and (2) the study of the character and activities of the general micropopulation of the soil.

Commercial preparations of nodule and other soil bacteria presumably beneficial to plant growth have been collected under more than 50 trade designations to the extent of more than 600 samples. In addition to these, 25 samples of seed inoculated with material of several kinds have been obtained.

Field comparisons of materials applied wet and dry have given results favorable to the former.

The samples collected, whether seed or cultures of organisms in packages, have been examined or are in the process of examination for their flora of microorganisms, principally their content of legume-nodule organisms, and for their ability to produce satisfactory nodulation and plant vigor on the legumes for which they are intended.

The quality of the samples of inoculating material for legumes of the major producers continues to be fairly good, but it was found that there are several small producing firms which manufacture practically worthless cultures.

Information concerning the quality of inoculants has been disseminated by letter, published lists, through the Extension Service, and by personal contacts. Companies which cooperate with the bureau have been notified of defects found in their material.

ROOT-NODULE BACTERIA

Several strains of nodule organisms for each of the common legume crops are maintained continuously by the bureau, and many of them are tested each year. For the less common crops, cultures are ob-

tained by exchange or by isolation, wherever possible. The collection contains cultures favorable for nearly all the legumes grown in the United States. These cultures are available for experimental work with other bureaus, colleges, experiment stations, or individuals doing research work in this field. Cultures belonging to various series are furnished from time to time to institutions or firms supplying the farmer with inoculating material.

The need for definite experimental results in the use of nodule bacteria under local conditions in widely separate regions is being met by cooperation with States and corporations or associations.

There has been much doubt expressed as to whether inoculation of a field planted continuously to the same crop should be repeated every year. Although the results of many experiments have been inconclusive, the most recent experiments of the bureau clearly support the advice to apply a fresh active culture each year.

In cooperative work with the Bureau of Animal Industry in Louisiana, in 1929, a part of a field of Austrian winter peas showed good nodulation and abundant evidence of nitrogen fixation. Part of the field showed nodulation but no visible advantage to the crop, the nodule organisms present apparently being parasitic. The organism isolated from these nodules was tested in the greenhouse with the same result. In the winter of 1930-31 Austrian winter peas were again grown in the same field, part with favorable inoculation, part with the unfavorable strain, and part without inoculation. The unfavorable results were repeated except that where a favorable culture was applied to the seed in addition, the crop was fully benefited by the nodulation obtained. Manifestly the use of a good culture produced favorable results in spite of the presence of an unfavorable nodule organism in the field soil.

COOPERATION IN THE INTRODUCTION OF LEGUME BACTERIA

There continued to be a demand on the part of extension agents, instructors in vocational schools, chambers of commerce, and Members of Congress for assistance in the introduction of legume growing by furnishing free inoculation. These demands have been complied with so far as they have seemed reasonable. Some individual requests from farmers have continued to come in. The cultures sent out in response to various demands have totaled about 4,000 during the past year. Every effort is made to acquaint all inquirers with a list of institutions and commercial firms supplying inoculating material of satisfactory quality.

PAPER-MULCH STUDIES

The influence of paper mulch on the activity of the soil microorganisms has been studied, especially as regards the production of nitrates. The influence of the higher moisture of the mulched soil seems to increase the soil microflora but does not increase the nitrate content. It seems, however, to affect the distribution of the nitrates, and this may prove a very important factor. In the unmulched soil nitrates accumulate at the surface, whereas in the mulched soil they are evenly distributed to considerable depth.

STUDIES ON THE OCCURRENCE OF RADIOBACTER

Bacillus radiobacter has been found to dissociate in culture into the so-called "rough" and "smooth" types of growth. The crown-gall organism, *Phytophthora tumefaciens*, also dissociates, therefore these two can not be distinguished from each other by this phenomenon. Conditions favoring dissociation have been studied and attempts made to evolve a "radiobacter strain" from the pathogenic crown-gall organisms.

MICROBIOLOGICAL STUDY OF SELECTED SOILS

The experimental work for the purpose of following the changes in nitrogen in a number of selected soils has been continued. Soils were selected which are or have been used in connection with studies on other subprojects.

Of two sections of each soil in the greenhouse, one was kept fallow and the other was divided into two equal parts. One subsection was planted to corn and the other to wheat. Favorable conditions as to temperature, moisture, and aeration were maintained. Potash and phosphate fertilizers were applied in quantities sufficiently large to eliminate potash and phosphorus as limiting factors.

Continuous removal of crops of wheat and corn has decreased the yield, especially of corn, materially on all of the eight different soil types examined, except the "white alkali" soil from Colorado. The toxicity of this soil seems to have decreased, and yields obtained have shown gradual increase.

Studies of the microorganisms on the roots of the plants have shown that the roots of corn carry considerably greater numbers of fungi and bacteria than the surrounding soil. In certain slightly acid soils *Trichoderma* seemed to predominate, and in the alkaline soils no one species of microorganism seemed to outnumber the other.

GREEN-MANURING EXPERIMENTS

In green-manuring studies previously reported it was noted that the different green-manuring treatments had noticeably different effects on the succeeding corn crop. The treatments were therefore continued and records kept of the crop yields.

Where corn was planted immediately after the green manure was turned under, the rye had an inhibiting effect on the growth of corn. This was true on both limed and unlimed plots. However, when vetch was used in the same way the results were beneficial, and high crop yields were obtained.

GREENHOUSE AND FIELD STUDIES OF SOIL

Twelve plots of Keyport clay loam were established in the greenhouse. The following crops are grown for green manures: Timothy, peas, wheat, vetch, rye, and corn. On one plot of each kind the crops are turned under and in the duplicate plot the crop is left on the surface. Each plot is divided into two subplots, and corn is grown on one and the other is left fallow. The results to date show that the successive corn crops give the best returns when the green

manure is turned under. Evidences of nitrogen starvation are especially noticeable on the nonlegume plots. Records of yields and nitrogen removed are being kept, and the nitrogen-fixation question on these plots will be studied.

FUNGI OF THE SOIL

Cultures from vetch and rye left to decay on the surface show that the number of fungi in the decomposing material increased enormously, whereas the numbers in the soil, except in the surface one-fourth inch, did not change materially.

The distribution and character of the fungous element in all bacterial-culture work has been followed and reported with the bacteriological results, project by project. As a result of these observations a revised system of sampling has been developed in which the plant remains on the surface of the soil are taken first, then the soil is taken layer by layer to the usual depth of about 6 inches. Studies by this procedure have clearly shown that the fungi play a much larger part in the decomposition of organic remains on the surface than in material buried deeply in the soil. The numbers of microorganisms involved in such surface decomposition are prodigious in contrast to those in the homogenized sample of soil alone, sieved free from obvious organic remains.

Scrutiny of the organisms taking active part in this surface decomposition, shows that black and brown fungi predominate. Selected species of *Alternaria* and *Cladosporium* characteristic of this group, when grown in pure cultures and analyzed for lignin, show roughly 20 per cent ligninlike bodies in dry matter. Since the lignin complexes form a large part of the so-called humus of the soil, these black and brown forms are shown to be direct contributors to soil organic matter. This led to studies in cooperation with the division of soil chemistry and physics, which are showing that these same fungi make a notable contribution to the colloid fraction of the soil.

Experiments to determine just what part each of these groups of organisms plays in the breakdown of crop residues and other plant remains are in progress.

Another group of colorless and bright-colored soil fungi have been found, in the cooperative work with the division of soil fertility, to produce other organic constituents of the soil, the source of which had been previously unknown.

The study of the *Myxomycetes*, whose presence in the decomposing matter on the surface of the soil and in the soil itself was reported last year, has been continued. Surveys have shown amoeboids and plasmodia of this group to be present in decaying grasses and crop residues in many areas in the vicinity of Washington. Samples of soil at various depths, even mud from the bottom of lily ponds, have shown these organisms. Experiments to determine their physiological requirements and significance show that the organisms are most active vegetatively at 55° to 65° F., temperatures common in the soil during much of the growing season, whereas at higher temperatures they tend to fruit. In laboratory cultures they attack and disintegrate mold colonies and infest

other organic materials. Quantitative determinations of their biochemical activities are difficult because of the fact that it is practically impossible to grow them free from bacteria.

COOPERATIVE WORK

The National Institute of Health has continued to refer to this bureau calls for information about molds and for their identification, even in connection with human diseases.

The significance of certain common molds as causes of the allergic diseases has been worked out in cooperation with specialists on asthma and hay fever. Several groups of investigators in this field are making demands on this division for identification of their cultures and for the use of cultures already found active in connection with our experiments.

The importance of this field to the relief of individual suffering is considerable. Species of *Aspergillus*, *Penicillium*, *Alternaria*, *Cladosporium*, *Polyporus*, *Monilia* (*Neurospora*), and *Cephalothecium* have already been found accountable for these diseases in a series of cases, and the work has only begun.

There is continued interest in the application of species of *Penicillium*, *Aspergillus*, and related genera, long studied in this division, to industrial fermentations and to decompositions of various kinds involving loss or deterioration of different substances. A steady demand for conference, for the identification of organisms, and for supplying named cultures, is the natural corollary to the work already done.

During the past year collections of type cultures of *Aspergillus* and *Penicillium* have been furnished to Harvard University, the New York Botanical Garden, the Missouri Botanical Garden, and the University of California. A series of pill-box type specimens is being prepared for Kew Gardens, London, England.

FERTILIZER AND FIXED NITROGEN INVESTIGATIONS

This unit of the Bureau of Chemistry and Soils has for its objective the development of better and more economical methods of fertilizer production and use, to the end that our farmers and manufacturers, as well as the consuming public, may realize the maximum benefit to be derived from manufactured plant food. Inasmuch as it is the aim to improve a going industry, a little explanation of the situation as it is now will be helpful in reporting the activities and accomplishments of the year.

The American farmers' fertilizer bill amounts to approximately \$250,000,000 a year. This is what they pay for some 8,000,000 tons of material prepared for application to the soil and containing about 350,000 tons of nitrogen, 800,000 tons of phosphoric acid, and 350,000 tons of potash in such form as to be available to growing plants within a reasonable length of time.

The fertilizer business of to-day is the result of 80 years of progressive change. With each improvement its scope of usefulness has been increased until now the industry contributes to the well-being of a large part of humanity. The United States ranks second only to Germany in the total quantity of commercial fertilizer used.

and may be reasonably expected to take first place at any time and hold that position indefinitely, since there is no other competitor for first place. This country is independent in its phosphate supply and is rapidly becoming independent in its nitrogen supply, because of the recent growth of nitrogen fixation in the United States. However, a large part of the potash required is still imported.

Unquestionably the increase in fertilizer consumption is due mainly to the fact that its judicious use reduces the cost of crop production. Low prices and narrow margins of profit, such as the farmer must now contend with, leave little incentive to larger production except as larger yields mean lower unit costs. The farmer's faith in the ability of commercial fertilizer to help even in times of depression is evidenced by the fact that fertilizer sales have held up remarkably well and compare favorably with other lines of business in spite of reduced buying power on the farms. Fortunately nature restores a part of the soil fertility removed by cropping or by leaching and erosion or other damaging processes, but the maintenance of a high state of productivity requires, in addition, an artificial supply of certain of the elements lost.

The very best methods must be discovered and employed in the production and application of plant food if the maximum economic advantage is to be secured. It is an extremely intricate problem. The research activities include the development of new manufacturing processes and the improvement of those already in use, the production of new compounds, the investigation of new raw materials or by-products from other industries, and the determination of the characteristics of new products suggested for fertilizer use. The solution of the main problems often calls for the use of much fundamental chemical data which can be developed only by a comprehensive research program.

NITROGEN

Fixed nitrogen has a multitude of uses in agriculture and refrigeration, and in the manufacture of chemicals and explosives. Agriculture leads with a consumption of 75 per cent of all nitrogen used in the United States and 87 per cent of the world's supply. By the year 1900 it became apparent that nitrogen would be required in addition to the current supply of organic materials, Chilean nitrate, and ammonium sulphate from the by-product coke ovens and gas works; therefore, the problem of fixing atmospheric nitrogen was studied diligently by scientists in Europe and the United States, with the result that three commercial processes—the arc, the cyanamid, and the direct synthetic-ammonia processes—were developed on a commercial basis. For many years this bureau has been active in promoting the establishment of nitrogen fixation in the United States, especially the direct synthetic-ammonia process which is now an important factor in American industry. The trend has been definitely toward the use of the direct synthetic-ammonia process, and therefore the bureau has confined its research very largely to this process which seems to have the greatest possibilities for cheapening the cost of producing fixed nitrogen. Working in close cooperation with the industry, this bureau has contributed in a major way to the understanding of this chemical process by American manufacturers

whose fixation plants have been constructed and are being operated by organizations containing many chemists and engineers formerly engaged in the work of the bureau. The fixation industry in the United States has increased its capacity rapidly during 1930 and 1931, with the result that this country is practically self-sustaining and would suffer only slight and temporary inconvenience should all imports of nitrogenous materials be stopped at any time.

CATALYSTS FOR AMMONIA SYNTHESIS AND OXIDATION

In the fixation of atmospheric nitrogen by the direct synthetic-ammonia process a highly purified mixture of nitrogen and hydrogen, in the proper proportions to form ammonia, is highly compressed and passed over a catalyst at an elevated temperature. The catalyst, consisting ordinarily of iron containing small percentages of such substances as aluminum oxide and potassium oxide, greatly increases the rate at which the two gases combine. In fact, nitrogen gas is so inert that the process depends directly on the presence of a material that can speed up the reaction. A considerable part of the early research activities of the laboratory was devoted to the production of a suitable catalyst for use under manufacturing conditions, and this work resulted in decided success. The research activities along this line are being continued, but at the present time are more concerned with the factors that influence and determine the activity of catalytic substances. By studying the fundamentals of catalytic reactions and discovering how and why these substances act as they do, a sound basis is established for the improvement of catalysts and thus also of the efficiency and usefulness of the nitrogen-fixation industry. Much of the information being obtained is also directly applicable to numerous other chemical industries in which catalytic processes are coming into more common use.

Investigations during the year have gone far toward determining the mechanism by which ammonia catalysts function. The indications are that the iron catalysts are particularly effective in ammonia synthesis because, as experiments during this last year have shown, nitrogen can react with active iron atoms on the surface of the catalysts to form a surface iron nitride. This nitride in turn is capable of reacting with hydrogen to produce ammonia and form again the catalytic iron. Recently completed experiments on the composition, conditions of formation, rates of thermal decomposition, and rates of reduction by hydrogen of the various nitrides of iron are in agreement with this postulated mechanism of ammonia synthesis. The results of these experiments will also be of use to those interested in case-hardening steels by nitriding with ammonia.

One of the leading processes for the production and purification of hydrogen used in ammonia syntheses is also dependent on a catalyst. The hydrogen produced by the passage of steam over hot coke contains some 35 per cent carbon monoxide, a substance which is very poisonous to ammonia catalysts. The removal of this impurity is ordinarily effected commercially by causing it to react with steam over proper catalysts to form hydrogen. Work during this last year on the iron oxide catalyst usually used for this purification has resulted in much new data of use not only in the prepara-

tion and purification of hydrogen but also in the metallurgy of the reduction of iron ores by hydrogen at high temperatures.

Nitric acid and nitrate fertilizers are produced from synthetic ammonia by a process known as ammonia oxidation. In fact a major part of the synthetic-ammonia production of the country is used in this way. In the first step of this process the oxygen of an air-ammonia mixture is caused to react with ammonia by means of a catalyst, such as platinum, to form nitrogen oxides. The oxides can then be converted easily into nitric acid and various nitrates for direct use as fertilizers. The platinum catalyst performs a function in this reaction analogous to that performed by iron in ammonia synthesis and is likewise easily poisoned by certain impurities that are sometimes present in the gases involved. Studies have been completed recently on the effects of various poisons on these platinum catalysts for the oxidation of ammonia to oxides of nitrogen; the results should prove of interest both to the industrial chemist and to those interested in the mechanism of catalytic reactions in general.

HIGH-PRESSURE STUDIES

Commercial ammonia synthesis is carried out at pressures ranging from 1,500 to 15,000 pounds per square inch. Under these conditions the physical properties of the gases can not be estimated even approximately by the laws governing the behavior of gases at ordinary pressures. Accordingly, in order to design high-pressure machinery and completely to understand the chemical equilibria involved, the behavior of the gases alone and in mixtures must be measured in detail over a wide range of temperatures and pressures. Such data, when they have once been worked out for the benefit of the nitrogen industry, are equally valuable to other industries using high-pressure gas reactions.

The first investigations were detailed studies of the two gases essential to ammonia synthesis, namely, hydrogen and nitrogen; more recently the work was extended to include carbon monoxide and methane, both of which are of interest in connection with the production of hydrogen. During the year helium was added to the list, as it is considered desirable to know the compressibility of this chemically inactive gas which is only slightly adsorbed by most catalysts. Such knowledge is needed in the determination of the adsorption of various gases under high pressure. The solubility of hydrogen in water at 25° C. and at pressures up to 15,000 pounds per square inch has been determined. The work will be extended to include the solubility of the other gases in water under similar conditions and at various temperatures and also their solubility in liquid ammonia.

UREA PRODUCTION

The product of the synthetic-ammonia process is ammonia which is a gas under ordinary conditions and therefore not directly applicable as a fertilizer. It is a very cheap nitrogenous material and is readily converted into products suitable for use on the soil. For example, great quantities of ammonium sulphate, ammonium phosphate, sodium nitrate, calcium nitrate, and ammonium nitrate are

made in this way at various plants throughout the world. The ammonia output is now the controlling factor in the nitrogenous-fertilizer market. Another material, urea, seems to have good possibilities, since it is a highly concentrated fertilizer and requires only ammonia and carbon dioxide for its production. Since carbon dioxide is produced in great quantity and wasted as a by-product at the synthetic-ammonia plants, its use with ammonia by means of an efficient process should yield a cheap and desirable product. Although already produced and marketed for fertilizer use, the cost of production is still too high to encourage general use.

On being mixed, ammonia and carbon dioxide unite almost instantaneously to form a solid compound, ammonium carbamate, from which urea may be obtained by heating to a temperature of 150° C. in a closed vessel. A small-scale plant, constructed by the bureau several years ago for the production of urea in this way, was operated to obtain information on the conditions favorable to urea formation and gave much useful data and also brought out the need for more exact knowledge concerning the reactions and equilibria involved. A series of laboratory investigations was initiated and is still in progress to give the required information. The conditions for the synthesis of urea from carbon dioxide and ammonia have been fairly well worked out, and attention is now directed especially to the recovery of unconverted carbon dioxide and ammonia from the urea formed, either by separation of liquid from solid or of gas from liquid. The present study of vapor pressures over synthetic mixtures will indicate the conditions necessary in the operation of a still for the separation of the gases from a solution of urea.

Results from a study of the melting temperatures of conversion mixtures of ammonium carbamate to urea have furnished information valuable for the removal of the mixtures from the autoclave and in the recovery of gaseous carbon dioxide and ammonia. A minimum temperature of 65° C. in the still has been shown necessary for the recovery of these gases. Also the possibility has been indicated of a partial separation of urea from the other products by withdrawal at a temperature of 70° to 80° C. of liquid from a solid formed.

PHOTOCHEMISTRY OF NITROGEN

There are various ways of rendering the inert nitrogen molecule chemically active. Heat and electricity are effective when properly applied, and results obtained in this bureau have indicated that ultra-violet light having very short wave lengths is an agency to this end. This suggested numerous possibilities and explained some of the facts already known. Spectroscopy has recently furnished detailed knowledge of the structure of the nitrogen molecule, and it is now possible by means of ultra-violet light to alter the structure so as to render this exceedingly inert substance chemically active.

During the past year the study of the elementary processes leading to the oxidation of nitrogen has yielded results decidedly encouraging to the effort which is being made to elucidate the fundamental changes that bring chemical reactivity into the ordinarily inert nitrogen molecule. The methods of band spectra and molecular physics seem to allow a direct way of getting to the answer of this

problem. The progress of a study of the formation of nitric oxide from activated nitrogen molecules has been reported during the year. In connection with the molecular structure investigations, a complete report has been submitted and accepted for publication covering the work on the structure of the ozone molecule, an important substance in the chemistry of the nitrogen oxides, and also a molecule possessing remarkable similarity to the molecule of nitrous oxide. The investigation of the structure of nitrous oxide, planned beforehand logically to follow this, has progressed rapidly, and a first report is nearly completed. It has been shown that this molecule is probably broken to pieces as a primary process by the absorption of ultra-violet light, and it seems very probable that it will be possible to specify what the resulting fragments of this dissociation are. This last result, at first not foreseen, came somewhat unexpectedly and illustrates the peculiar adaptability of spectroscopic methods to these studies. Investigation of certain of the properties of some nitrogen-containing molecules has recently been started through a study of their infra-red spectra, a method suited to this investigation because of the relative simplicity of the spectra of these molecules in this region.

The work on the photochemistry of nitrogen originated as an outgrowth of work on the arc process of nitrogen fixation but is not now being conducted with any idea of developing an improved arc process; the purpose is more fundamental, namely, to get at the scientific explanation of how and under what conditions light can so radically modify gaseous nitrogen.

NITROGEN FIXATION BY LIVING ORGANISMS

Although we have no way of estimating the quantity of nitrogen fixed annually by biological agencies, it is generally conceded that the total supply produced by industrial processes is but a small part of that constantly being fixed by natural agencies. This means that the main supply of nitrogen used by crops has been previously fixed by living organisms. The three types of nitrogen-fixing organisms, responsible for most of the fixation, are being studied. These consist of the free-living soil organisms, such as *Azotobacter*; the nodule bacteria that live on the roots of leguminous plants; and certain blue-green algae. The purpose of this work is to discover the mechanism by which these lower forms of plant life are able to use inert nitrogen gas. Such living organisms fix nitrogen at ordinary temperatures and pressures and require no appreciable energy other than for growth. If nature's apparently simple system were known, it might be possible to devise very simple industrial fixation processes. An intensive study is being made of this promising field of investigation.

Previous experiments with *Azotobacter* conducted by this unit had shown that no appreciable quantity of energy is required for fixation; furthermore, that either calcium or strontium is essential, and that small concentrations of a readily available nitrogen compound are sufficient to prevent all fixation. Further studies with *Azotobacter*, conducted during the past year, have thrown additional light on the chemical mechanism by which these bacteria fix nitrogen. It has been shown that the first step in the process of fixation is brought

about by means of an enzyme. This enzyme has been named azotose and a number of its physico-chemical properties determined, such as dissociation constant, heat of reaction, free energy of reaction, and temperature coefficient with respect to nitrogen gas. As one method of attempting to isolate this intracellular nitrogen-fixing enzyme, a study has been made of the behavior of *Azotobacter* under abnormal conditions. It was desired to prevent growth and respiration without causing a general deterioration of the whole organism, especially the nitrogen-fixing mechanism. A number of methods of doing this were studied, including variations in acidity, temperature, hydrogen peroxide, nitrite, carbon dioxide, and oxygen deficiency. Conditions have been found in which growth and respiration are prevented, but the nitrogen-fixing enzyme is unaffected. Until the enzyme has been obtained free of the bacterial cell, however, we can not be certain of its exact chemical composition. Possibly either calcium or strontium, known to be essential for fixation, is definitely connected with the enzyme.

Another phase of the work with *Azotobacter* has dealt with the energy requirements of the organisms for growth on the one hand and for fixation on the other. A method of determining the energies of certain reactions, occurring within living organisms, has been developed and applied to nitrogen fixation. The energy requirement for the first step in nitrogen fixation was found to be negligibly small. Considerable energy is, of course, required for the growth of the organisms apart from fixation. The *Azotobacter* studies are, in their present stage, of a strictly fundamental nature.

It had been previously demonstrated that legume-nodule bacteria did not fix nitrogen when growing apart from the host and that bacteria had been grown under a variety of pressures of nitrogen, hydrogen, and oxygen. During the year studies with leguminous plants grown with artificial light sources have been made. Variations in light sources, intensities, and length of day have been studied in an attempt to obtain growths more nearly comparable to those obtained in sunlight. The effect of numerous factors on nodule production and in turn on nitrogen fixation have been considered. Methods for growing plants under aseptic conditions in the presence of known gas mixtures are being developed.

Blue-green algae, the only chlorophyll-containing plants definitely known to fix nitrogen without the aid of bacteria, have been isolated from the soil and the fact established that these organisms grow practically as well in the absence as in the presence of fixed nitrogen, using sunlight as their only source of energy. The mineral requirements of certain nitrogen-fixing blue-green algae are being studied. These studies are planned to determine the elements essential for growth but more especially the elements required to catalyze the fixation process. It is also desired to determine if chlorophyll plays a direct part in the fixation mechanism or merely enables the plant to utilize light as a source of energy. The economic importance of these organisms can not be estimated from our present limited knowledge, but they are widely distributed in soils, fresh-water lakes, and streams and are doubtless responsible for considerable nitrogen fixation.

RELATION OF NITROGEN TO ORGANIC COMPOUNDS

It has been noted that most of the fixed nitrogen available in nature is that fixed by living organisms. These nitrogen-fixing organisms store the fixed nitrogen almost wholly in organic form, principally as proteins and amino acids. We do not as yet know the first step in the fixation process, but this, too, is probably organic in character. It seems reasonable that eventually a nitrogen-fixation method can be found to use organic materials without the aid of the living organism. An attempt to do this is being made by cooperation with those working with living nitrogen-fixing organisms and by a study of certain organic compounds which appear to possess promising properties with respect to nitrogen.

The cracking at high temperatures of certain organic compounds known as ketazines has been studied. They were found to give off nitrogen freely at a temperature of 300° C. The end products were identified and quantitatively determined. The second phase of this work, which involves a study of the behavior of this process at high pressures of nitrogen, is now being carried out. This will show whether or not an equilibrium exists and consequently whether or not the reaction can be reversed so as to fix nitrogen.

Results have been obtained which indicate that many common organic compounds are actually highly active chemically. Certain classes of these compounds, the ketones and aldehydes, are known to be present in bacteria, and it seems possible that the fixation of nitrogen by bacteria may involve the attachment of nitrogen to these free radicals. This lead is being pursued not only synthetically but also from the standpoint of studying the chemistry of the *Azotobacter*. Considerable progress has already been made in this latter direction and fairly large quantities of bacteria are now being produced.

Another phase of the work deals with chlorophyll, the plant substance responsible for the fixation of carbon in nature. The energy-containing materials, synthesized by means of the chlorophyll, using sunlight as a source of energy, are essential for biological nitrogen fixation. In the case of the nitrogen-fixing algæ the question arises as to how closely the chlorophyll present plays a part in the fixation process. In the case of bacteria the rôle is necessarily an indirect one. The relationships between nitrogen fixation by organisms, their process of photosynthesis, and utilization of energy are so interwoven that it becomes highly expedient to treat the subject as a whole in the research program. The results obtained should be of direct interest to those working on various plant problems and in other branches of agriculture. During the past year most attention has been given to the preparation of pure chlorophyll. Its production and that of the yellow pigments, carotene and xanthophyll, have now been placed on a semicommercial basis. Quantities considerably larger than those ordinarily made in a research laboratory are being turned out.

POTASH

American agriculture is still largely dependent on foreign sources for the potash which it requires. Although the domestic production for the year was essentially the same as for the preceding year and amounted to less than 20 per cent of the requirements of the country,

developments were initiated that will, when completed, have a marked effect on the situation. The plant of the largest present producer was in process of expansion at the end of the year and an entirely new factor has been introduced with the opening of a potash mine in New Mexico. This mine is already producing crude potash salt suitable for direct use as fertilizer, but too low in potash to justify shipping to the more distant fertilizer-consuming areas of the United States. However, the crude salt is water soluble and adapted to refining by the simple methods used in the European potash industry, and it is reported that a plant will be constructed for this purpose. It seems that the output of this mine, when well into production, together with the output of the enlarged California plant, using natural potash-borax brine, will go a long way toward the realization of an American potash industry commensurate with the needs of the country.

However, potash imports amounting to some 900,000 tons must be replaced by domestic production before the country is independent in respect to this fertilizer material. One purpose of the research work of this bureau is to find methods for the production of potash at low cost from our abundant potash-bearing minerals that have as yet proved too refractory for economical utilization.

The several methods now in use or being developed for potash manufacture may conveniently be grouped under two general types namely, wet extraction and furnace methods. In the wet-extraction processes the potash is produced by crystallization from natural brine or brine made from solid salt or by treatment of the mineral with such reagents as mineral acids, certain alkalies, and nitrogen oxides in the presence of water. The furnace methods differ radically from all others in that the potash salts are volatilized and recovered directly from the furnace gases.

WET-EXTRACTION METHODS

The potash-bearing mineral, alunite, which occurs in large deposits in southern Utah, represents an entirely logical raw material for potash and alumina manufacture because of its high content of these constituents and the relative ease with which they may be separated, yet the processes heretofore applied commercially have failed to meet the economic requirements of competitive conditions. Contributory to this situation is the fact that the alumina, a by-product of importance if not essential to the success of the proposed manufacture, has not been obtained sufficiently pure to enable it to enter the preferred market. This has been due to the fact that certain impurities, particularly silica, naturally present in the potash-bearing mineral, accumulate in increased concentrations in the alumina. A process has been devised and tested with affirmative results whereby the silica is eliminated as fluosilicic acid. Further work in progress has as its objective the elimination of iron. Improvements in heat treatment are expected to yield more uniform products, reduce fuel costs, simplify plant equipment, and reduce losses. A further objective is the utilization of the lower-grade alunite, as well as the high-grade mineral to which past operations have been restricted, with a view to increasing the potash potentialities of that raw material.

Enormous deposits of another potash-bearing mineral, leucite (Wyomingite), occur in Wyoming. Fortunately, large deposits of high-grade phosphate rock and various other raw materials useful in fertilizer manufacture, together with abundant and cheap fuels, are near by. Various researches are in progress to develop chemical processes best suited to this unique industrial situation. The production of available potash from leucite by treatment with the oxides of nitrogen and the various industrial acids is being studied, particularly from the viewpoint of by-product recovery.

Other potash-bearing materials, such as the greensands of New Jersey and the shales of Georgia, are being subjected to lines of attack similar to those used for leucite. In the case of the acid extraction of greensand, iron and aluminum salts and adsorptive silica (glaucosil) are obtained as useful by-products.

FURNACE METHODS

Fundamental research on the furnace treatment of various minerals for the volatilization of potash from its ores by blast furnace procedures is yielding promising results. Electrical precipitation is used in this method for the recovery of the potash salts evolved as finely divided particles in the furnace gases. Preliminary results indicate the entire practicability of the method, particularly so when the furnacing of the leucite is combined with that of phosphate rock to yield both phosphoric acid and potash. The combination of these two fertilizer essentials to form the highly concentrated fertilizer salt, potassium phosphate, is contemplated as a logical means of reducing distribution costs. These costs must be given serious consideration where the fertilizer resources are far removed from the fertilizer-using areas. The blast furnace offers itself as a useful nucleus around which to assemble other chemical activities, due to the large volume of surplus gas it generates. The technology of potash recovery by blast-furnace methods, once developed as a part of the problem of smelting potash silicates, should also be applicable to the recovery of potash now currently liberated and lost in the iron and cement industries.

A number of small blast furnaces have been built and operated during the last three years. The furnace in use during the latter part of the year is built to handle some 30 tons of raw materials per week of operation (24 hours per day). The furnace plant is a complete unit provided with an electrical precipitator for recovering the product, and it burns its own gas for preheating the blast. New Jersey greensand has been smelted in short preliminary runs, and it is hoped that further work will result in a commercially profitable industry based on this abundant material.

PHOSPHATES

It has been noted that the American farmers spend about \$250,000,000 annually for fertilizer. About one-third of this represents the cost of phosphoric acid.

Fortunately, this country is well provided with large reserves of phosphate rock, in Florida and Tennessee, to supply the phosphate requirements of the South and East, where fabricated fertilizers are now more generally employed. Wyoming, Montana, and Idaho

have enormous deposits in juxtaposition to large potash deposits, to supply the future fertilizer requirements of the Middle West. Here the logical expansion of fertilizer use is to be promoted by a reduction in distribution costs to follow the development of close-by industries and more highly concentrated products. In this connection it should again be pointed out that although fertilizers are sold on the basis of plant-food content, freight is paid on weight. Distribution costs are accordingly reduced in proportion to concentration increase, a factor favoring producers wherever located.

Present methods of manufacturing superphosphate require high-grade rock. Accordingly, in mining, the better grades of rock are recovered, and the rest are discarded as waste except where flotation methods are used. The main purpose of the phosphate-research program of this bureau is to work out methods for the more economical conversion of these phosphate minerals into suitable available fertilizers with the conservation of the by-products. It is desired particularly to develop methods for the utilization of the low grades, or run-of-mine phosphate rock, thus not only materially reducing mining costs but also greatly prolonging the life of the deposits.

The furnace methods discussed in connection with potash manufacture are being applied with minor variations to the production of phosphoric acid. The work indicates that these methods will allow the utilization of low-grade phosphate rock, now discarded, and produce highly concentrated products. Tennessee "blue rock," a phosphate mineral not commercially useful for fertilizer production, has been smelted with every indication of success. Run-of-mine Florida phosphate rock also has been used in the furnace without preliminary treatment, such as washing, sintering, and briquetting. The principal cost in the furnace production of fertilizer phosphates is the cost of the coke fuel. The aim of the work is to reduce this cost by improved furnace design and operation.

A study of the complete chemical composition of the various grades and types of phosphate rock has been completed. Several papers bearing on this investigation have been published in the technical and trade journals, and the results of the completed study are being prepared for publication as a department bulletin. This information is necessary as a basis for work on methods for the production of phosphate fertilizers and for the recovery of any impurities in phosphate rock that appear to have commercial value. Particular attention has been given to the occurrence in phosphate rock of magnesium, nickel, copper, manganese, chromium, vanadium, arsenic, and iodine, which may be either beneficial or detrimental to plant growth. X-ray studies have shown that phosphate rock consists principally of a complex calcium phosphate having the general structure of the crystalline apatites. The relation of the various impurities in phosphate rock, such as carbonates, sulphates, and fluorine, to the chemical constitution of the natural rock is being investigated. This question has an important practical bearing on the concentration of crude phosphates by flotation processes which are coming into use in the Florida and Tennessee phosphate fields. Results have shown that fluorine is definitely combined as a part of the phosphate-bearing mineral. Critical studies of methods for determining the various elements in phosphate rock have been made, and several improved

methods, particularly for the determination of fluorine, have been developed.

Extensive investigations are being carried out on the chemical constitution, preparation, and properties of the complex calcium phosphates present in phosphate rock, in bone, and in superphosphates that have been treated with relatively large quantities of ammonia. These studies are of a fundamental character and it is expected that the results will be of great value, not only to the phosphate-rock and phosphate-fertilizer industries but also to the agronomists, soil scientists, and biochemists. The X ray is playing a very valuable and essential part in these studies.

Most of the phosphoric acid manufactured in this country is now produced by the sulphuric-acid process. Possible improvements in this process have been given consideration. Investigations on the use of dilute phosphoric acid and of mixtures of phosphoric acid and sulphuric acid in the manufacture of concentrated superphosphates were continued.

Particular attention is being given to laboratory methods for determining the availability of phosphatic fertilizer materials. In this connection studies on the solubility of a wide variety of phosphates in neutral ammonium citrate and 2 per cent citric-acid solutions were made, and the factors affecting the solubility of dicalcium and tricalcium phosphates in ammonium-citrate solutions were investigated. This work is closely related to the investigations on ammoniated superphosphate discussed elsewhere.

Among the important by-products of phosphate production are fluorine compounds, particularly the fluosilicates. These offer interesting possibilities as substitutes for arsenic compounds in the manufacture of insecticides. The factors involved in the production of fluorine compounds as by-products of the phosphate-fertilizer industry are being investigated. The comparatively low availability to plants of raw phosphate rock seems to be due principally to the fact that the phosphate is combined with fluorine, and the conversion of phosphate rock into readily available fertilizers requires the breaking up of this complex. Particular attention is being given to methods for the removal of fluorine from the rock. This work is of practical importance not only from the standpoint of the fertilizer industry but also from the standpoint of the use of phosphate rock as a mineral supplement in the feeding of livestock, since it is known that fluorine is detrimental to the health of animals.

NEW FERTILIZER MATERIALS AND IMPROVED DISTRIBUTION

The most interesting of the recent developments in fertilizer manufacture is the direct use of synthetic ammonia in fertilizer mixtures containing superphosphates. The present price of ammonia is considerably less than that of any other form of nitrogen, and its use as a fertilizer material has thus resulted in a marked reduction in the cost of fertilizer nitrogen. The use of free ammonia in the manufacture of fertilizer mixtures has the further advantages that it greatly improves the mechanical condition of the mixture, prevents rotting of the bags, and affords a means for reducing freight and handling charges by increasing the concentration of the fertilizer.

It has been found, however, that the direct use of free ammonia in the manufacture of fertilizer mixtures brings about an apparent reduction in the availability of the phosphoric acid in the fertilizer, as indicated by the present official method for determining availability, when the ammonia added is in excess of about 1 per cent of the mixture. The present use of free ammonia is therefore limited to about one-fourth of the maximum that it is possible to include in a fertilizer mixture.

A study made in this bureau of the composition and properties of the products formed in the reversion of phosphoric acid indicated, however, that the availability of these materials to plants should be greater than the present official method for measuring phosphoric-acid availability would indicate. This was later confirmed on submitting samples of various forms of reverted products prepared from ammoniated superphosphate to different agricultural experiment stations throughout the country. The importance of this problem and the interest that was taken in the work is evidenced by the fact that the tests were undertaken in 25 different State experiment stations and other institutions in the United States.

The results obtained in this collaborative study show that it should be possible at least to double the quantity of free ammonia now used in preparing fertilizer mixtures without decreasing appreciably the fertilizing value of the phosphoric acid in the mixture. Steps are accordingly being taken by the official organization of the State control chemists which will allow an increase of about 100 per cent in the use of free ammonia in the preparation of fertilizer mixtures. This will provide for an increase in the use of synthetic ammonia in the ammoniation of superphosphate in this country of at least 80,000 tons per annum, having a wholesale value of about \$8,000,000.

The direct use of anhydrous ammonia in fertilizer mixtures is of further interest in that it neutralizes any excess of acid present, and the heat developed when the ammonia is incorporated in the mixture provides a means for eliminating any excess moisture. A study is accordingly being made of the possibility of applying a continuous process in the preparation of complete concentrated fertilizers by treating phosphate rock with an excess of phosphoric acid with or without the addition of sulphuric acid, neutralizing the resulting slurry with free ammonia after the addition of such other components as are required in the mixture, and utilizing the heat of the neutralization to aid in the granulation of the mixture. A fertilizer prepared in this way offers advantages over simple mixtures of alkali salts as are now found on the market in that (1) it does not segregate, (2) it has better drillability, (3) it contains a lower proportion of readily soluble salts, and (4) it provides necessary plant-food elements, such as calcium and sulphur, in addition to the ordinary fertilizing elements.

A study has been made of methods of imparting different colors to synthetic fertilizer materials with a view to providing a means for readily differentiating between materials that are without marked distinguishing characteristics. The extent to which segregation takes place in fertilizer mixtures can be easily followed by this means, thus facilitating the study of methods for preventing this undesirable feature of mixed fertilizers.

A method of measuring the drillability of fertilizers has been devised that will enable implement manufacturers to calibrate fertilizer distributors more accurately than in the past. This method should also be of value to fertilizer manufacturers desiring to produce goods of uniform drillability and to agronomists in making field tests, since it gives control of a variable which in the past has been neglected but which nevertheless affects crop yields.

Some mixed fertilizers remain constant in composition during drilling, whereas others do not. The causes of this tendency of some mixtures to segregate are being studied with a view to devising preventive means.

Ways and means of promoting efficiency in the use of fertilizers for cotton are being studied in cooperation with the Bureau of Public Roads and the South Carolina Agricultural Experiment Station. This work has shown that greater uniformity of distribution than is commonly obtained with commercial distributors would increase the profits from the use of fertilizers. The placement of the fertilizer in the soil with reference to the seed has been found to be very important. When it is applied in contact with the seed at the rates recommended in the Southeastern States, germination is frequently injured and the stand is severely damaged. Results secured thus far indicate that when placed in bands about 2 inches to each side and at a depth about 2 inches greater than that of the cottonseed, ordinary fertilizers at a rate of 800 pounds per acre and double-strength fertilizers at a rate of 400 pounds per acre are both safe as regards germination and efficient in increasing yields. The most efficient placement, however, is yet to be determined. Some evidence has been obtained which indicates that the amount of increase in yield produced by fertilizer depends partly on the size of its grains. This project is being continued.

The work on the preparation of potassium nitrate by treating solid potassium chloride with oxides of nitrogen has been continued. Theoretical considerations and preliminary experiments indicate that the nitrosyl chloride formed during the preparation of potassium nitrate by the above procedure is perhaps best utilized by oxidizing it to nitrogen peroxide and chlorine, the former to be returned to the process to make more potassium nitrate. The chlorine may be sold as a by-product or otherwise disposed of.

ECONOMICS

The economic aspects of the work have been given due attention, probably closer attention than during any previous year. The general business and agricultural depression has served as a reminder of the necessity of directing effort in a way to assist most effectively the fertilizer industry and agriculture.

In estimating the probable value of any research project it is necessary to know the magnitude of that branch of the industry that may be affected by the results. Fertilizers of all sorts are world commodities, and their commerce is extremely complex. It is, therefore, not sufficient to know what is going on in the United States; a world view is required as a working basis in this field. Information of this character is gathered and published by the bureau for its own use as well as for the public service.

One of the outstanding events of the year was the reduced or part-time operation of the nitrogen industry throughout the world, due to the inability of the market to take the output of the manufacturing facilities which had been expanded so rapidly during recent years. This condition calls for the development and promotion of more economical methods for the conversion of ammonia into fertilizer materials.

COOPERATIVE ENTERPRISES

The investigations of the fertilizer and fixed nitrogen investigations unit have required the installation of special equipment and the development of advanced methods for such work as that being done in catalysis and on the properties of gases under high pressure. Modern physics technic, through the X ray, spectroscope, and other radiation methods is also being applied in a very effective manner. It is the policy of the bureau to make its highly specialized methods and apparatus available to all those interested and to cooperate with other branches of the department and with outside agencies. For example, during the past year cooperative tests were carried out for the Bureau of Aeronautics of the Navy Department on the catalytic purification of gases. A cooperative project with the Bureau of Standards is now being actively prosecuted for determining specific heats at low temperatures, heats of combustion, and free energies of organic substances suitable for use in nitrogen-fixation and fertilizer investigations. This bureau is working in close cooperation with the Smithsonian Institution on problems involving radiation methods as applied to nitrogen fixation and agriculture in general. As examples of cooperation on problems of mutual interest with agencies other than governmental might be mentioned the Carnegie Institute, Rockefeller Institute, Franklin Institute, universities, and colleges of this country. Through these contacts some of the more theoretical phases of the work originating in this unit, but remotely connected with the projects, have been carried out by these institutions and the results made available to the bureau.

PUBLICATIONS OF THE BUREAU OF CHEMISTRY AND SOILS ISSUED DURING THE YEAR JULY 1, 1930, TO JUNE 30, 1931

TECHNICAL BULLETINS

No. 211. Some Methods for Detecting Differences in Soil Organic Matter.

No. 212. Mechanical Analysis of Finely Divided Natural Phosphates.

No. 214. The Physical and Chemical Characteristics of Certain American Peat Profiles.

No. 225. Results of Fertilizer Experiments on Norfolk Fine Sandy Loam and on Norfolk Sandy Loam.

No. 228. Character of the Colloidal Materials in the Profiles of Certain Major Soil Groups.

No. 229. Variations of the Colloidal Material Extracted from the Soils of the Miami, Chester, and Cecil Series.

No. 232. A Laboratory Study of the Field Percolation Rates of Soils.

FARMERS' BULLETIN

No. 1643. Fire Safeguards for the Farm.

CIRCULARS

No. 129. Survey of the Fertilizer Industry.

No. 138. Development and Use of Baking Powder and Baking Chemicals.

No. 139. Method and Procedure of Soil Analysis Used in the Division of Soil Chemistry and Physics.

LEAFLETS

No. 69. Preservation of Leather Bookbindings.

No. 70. Home Mixing of Fertilizers.

No. 71. Fertilizers for Pecan Soils.

JOURNAL OF AGRICULTURAL RESEARCH ARTICLES

The Effect of Ethylene on the Chemical Composition and the Respiration of the Ripening Japanese Persimmon.

Progressive Changes in the Waxlike Coating on the Surface of the Apple During Growth and Storage.

The Adsorption of the Anions of Acid Dyes by Soil Colloids.

Vitamins in Sugarcane Juice and in Some Cane-Juice Products.

Notes on the Histology of the Almond.

Effect of Rye and Vetch Green Manures on the Microflora, Nitrates, and Hydrogen-ion Concentration of Two Acid and Neutralized Soils.

The Effect of Salt on the Microbial Heating of Alfalfa Hay.

Dispersion of Soils by a Supersonic Method.

SOIL SURVEYS

Muskingum County, Ohio

Milam County, Tex.

Hancock County, Ind.

Kent County, Mich.

Bartow County, Ga.

Prince Georges County, Md.

Eugene Area, Oreg.

Montgomery County, Ala.

Sauk County, Wis.

Bear Lake Valley Area, Idaho.

Wheatland Area, Wyo.

Menominee County, Mich.

Putnam County, Ind.

St. Lawrence County, N. Y.

Bergen Area, N. J.

Keith County, Nebr.

Clay County, Kans.

Navarro County, Tex.

Burke County, N. C.

Claiborne County, Miss.

Buckeye-Beardsley Area, Ariz.

Davie County, N. C.

Orange County, Va.

Polk County, Mo.

Grande Ronde Valley Area, Oreg.

Arkansas Valley Area, Colo.

Jackson County, Mich.

Washington County, Ohio.

Lee County, Ga.

Lenoir County, N. C.

Hardin County, Tenn.

Tuscola County, Mich.

Rankin County, Miss.

Wadena County, Minn.

Dukes and Nantucket Counties, Mass.

Lincoln County, Nebr.

Clarke County, Ga.

Watauga County, N. C.

Franklin County, Nebr.

Clay County, Nebr.

Camden Area, N. J.

Labette County, Kans.

Manitowoc County, Wis.

Crawford County, Kans.

Hamilton County, Nebr.

Hampshire County, W. Va.

Buchanan County, Iowa

Salt River Valley Area, Ariz.

Deming Area, N. Mex.

Lyon County, Iowa

Butler County, Ohio.

Custer County, Nebr.

MISCELLANEOUS

Fertilizer Experiments with Truck Crops. (Joint publication of the Florida Agricultural Experiment Station and the U. S. Department of Agriculture.)

Preliminary Report on Three Years' Fertilizer Experiments with Early Irish Potatoes on the Farm of A. W. Baker, Aurora, Beaufort County, N. C., 1928-1930. (Joint publication of the North Carolina Agricultural Experiment Station and the U. S. Department of Agriculture.)

Sources of Nitrogen for Potato Fertilizers in Aroostook County. (Joint publication of the Maine Agricultural Experiment Station and the U. S. Department of Agriculture.)

Use of Commercial Fertilizers in the Growing of Cotton. (Joint publication of the North Carolina Agricultural Experiment Station and the U. S. Department of Agriculture.)

YEARBOOK ARTICLES

Vat Dyes Play Big Part in Broadening Cotton Goods Market.

Legume Inoculation by Cultures Depends Finally on Field Test.

Hides and Skins Require Prompt, Thorough Curing to Bring Best Prices.

Paper Industry Concerns Farmer as Raw-Material Producer and Consumer.

Fruit Juices Preserved by Various Methods Find Steadily Growing Market.

Ethylene-Ripened Tomatoes Not Equal in Vitamins to Naturally Ripened Fruit.

Oranges Impaired in Vitamin-C Content by Arsenical Spray.

Fertilizer's Value Much Affected by Method of Applying It to Soil.

Nitrate Bacteria, Main Source of Soil Nitrates, Depend on Farm Practice.

Manure Substitutes Are Made from City Wastes by Various Processes.

Potash Extraction from Domestic Sources Has Great Possibilities.

Nitrogen Fixation by Legumes Essentially a Cooperative Process.

Fertilizer Studies Show Manner of Distribution Is Extremely Important.

Leather Injured by Mud, Water, and Heat; Preserved by Grease.

Insecticidal Plants Investigated as Possible Farm Crops.

Fruit Products Preserved Successfully by Freezing with Solid Carbon Dioxide.

Manganese and Other Less Common Elements Have Fertilizer Value.

REPORT OF THE CHIEF OF THE BUREAU OF DAIRY INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF DAIRY INDUSTRY,
Washington, D. C., September 1, 1931.

SIR: I submit herewith a report of the work of the Bureau of Dairy Industry for the fiscal year ended June 30, 1931.

Respectfully,

O. E. REED, *Chief of Bureau.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

The general research and service program of the bureau was carried forward during the year. With additional equipment and facilities it was possible to increase the amount of work which could be done in certain directions. The progress made in various lines of endeavor is summarized in the following pages, and attention is called to the necessity for expanding the research program of improving the Nation's herds of dairy cattle.

The present economic situation of the dairy industry emphasizes the need for more information concerning the production of dairy cattle. Records now available show that a large percentage of the dairy cows of the United States are returning little, if any, profit to their owners. The majority of the entire stock of dairy cows are low producers. Such cattle simply add to the production in the aggregate without returning to the individual farmer a satisfactory margin over his labor, feed, and overhead costs. More records on the production of the great mass of dairy cattle are necessary in order to carry out a satisfactory program which will mean definite improvement on a national scale.

The bureau's dairy-cattle breeding research and experimental work is now attracting much attention. Breeders of the country are taking more interest than ever before in the results of this work. This undoubtedly is due to the fact that a growing number of breeders of dairy cattle feel that the breeding methods they have been using have not resulted in the degree of success they had expected.

The results of the bureau's breeding work over the last 13 years now enable the bureau to recommend to breeders of dairy cattle, in order to insure success in developing herds possessing an inheritance for uniformly high levels of production, the continuous use of sires which have demonstrated through their progeny that they are transmitting high levels of production. These results indicate that success will follow the application of this principle of breeding whether

the system of mating used be outbreeding, linebreeding, or inbreeding.

As the keystone of this system of breeding is the proved sire, and as a sire can not be proved without an adequate number of accurate and uniform records of his offspring, it is highly important that efforts be made to greatly increase the work through which more records will become available. The best and most practical way to accomplish this on a national scale is, it seems, through the dairy herd-improvement associations. Excellent progress is being made in this dairy herd-improvement association work, but it needs to be increased and developed to the point where reliable production records on cows will be available in the numbers needed. With these records good bulls can be located, and through them the Nation's dairy cattle can be greatly improved. Production records are the basis of the bureau's breeding research and experimental work, and they are the basis for the practical improvement of dairy herds.

The principal item in the service work of the bureau begun during the year was an effort to improve the quality of the Swiss cheese produced in the State of Wisconsin, where 80 per cent of all the foreign-type cheese made in the United States is manufactured. The bureau entered into a cooperative agreement with the University of Wisconsin whereby the methods developed by the bureau for the manufacture of Swiss cheese are being introduced into cooperating Swiss-cheese factories in Wisconsin. Similar projects have been conducted in New York and Ohio during the past few years, with the result that great improvement has been made in the quality of the cheese manufactured in the factories cooperating with the bureau.

Considerable progress was made through the Extension Service in extending the results of the bureau's research work into the field and strengthening the State dairy-extension programs. The extension activities of the bureau are carried on cooperatively with the Office of Cooperative Extension Work. The four cooperative dairy extension specialists assigned to this work during the year emphasized three main projects: Dairy-herd improvement, dairy-cattle breeding, and milk-quality improvement.

Particular emphasis was given to ways and means of maintaining and strengthening dairy herd-improvement association work, especially the culling out of the lowest producers from the herds. Considerable culling resulted, and this undoubtedly benefited the producer.

The use of the "herediscope," a product of the research activities of the bureau, was demonstrated by the extension specialists in most of the States, to show by what procedure a dairy herd can be improved in production by applying the known laws of inheritance through the continued use of proved sires. The herediscope has proved to be a very effective aid in explaining the scientific principles of heredity. Although the subject of genetics has always been, at best, a difficult one to teach, this new extension work in dairy-cattle breeding, making use of the herediscope, is proving to be interesting, popular, and effective in the teaching of genetics, especially among practical farmers and breeders, and it is being rapidly adopted by the State extension services.

Another extension project which promises results of great value is the one on milk-quality improvement. Work on this project is

being done with both 4-H dairy club members and adult farmers. Suggested outlines for this work have been mimeographed and are available for distribution upon request to the bureau. These outlines show extension people how they may effectively add milk quality-improvement work to their dairy programs with both the club juniors and the adults. Extension Circular No. 146, which may be obtained free upon request to the Office of Cooperative Extension Work or to the Bureau of Dairy Industry, outlines the reasons why this project should be included in any State or county dairy extension plan.

In the course of the year, through conferences between the office of the Chief Coordinator of the Government, the Public Health Service of the Treasury Department, and the Bureau of Dairy Industry, an agreement was reached with respect to the relationship between the activities of the Public Health Service and those of this bureau with reference to the recommendations made to States, municipalities, and other communities, regarding the proper sanitary regulation of their milk supplies. The agreement provides for co-operation between the Public Health Service and the Bureau of Dairy Industry in promulgating an ordinance which will serve as a guide to States, municipalities, and communities in formulating ordinances which will be applicable to their local conditions.

The acreage of the United States Dairy Experiment Station at Beltsville, Md., was increased through the acquisition of 118 acres of land, 80 acres by purchase and 38 acres by transfer. With these additions the total acreage of that station is now 441 acres. During the past season 279 acres of this land were utilized for pasture and crop-production purposes.

On June 30, 1931, there were 354 animals in the herds at the Beltsville station, of which 230 were females over 1 year of age, 56 were females under 1 year of age, 24 were males over 1 year of age and 44 were males under 1 year of age.

Congress provided for another regional field experiment station. This new station, known as the Hatch Station, is near Hannibal, Mo., on land which formerly was the home farm of the late William H. Hatch, former Representative in Congress from Missouri. This farm was deeded by Mr. Hatch's estate to the State of Missouri, in order that it might be devoted by public agencies to the advancement of agriculture. Dairy-cattle breeding and feeding investigations will be conducted at this station in cooperation with the Agricultural Experiment Station of the University of Missouri.

The emergency appropriation made available to this bureau by Congress in connection with the President's program to provide work for the unemployed, enabled the bureau to give employment to more than 150 men, principally unskilled laborers, for varying periods, and at the same time advanced the bureau's construction program at certain of its dairy experiment stations.

Construction work at the Beltsville station included the completion of the physiological laboratory building, the construction of a mechanical shop building, a 100,000-gallon reservoir, and a shed for housing the combine milking machine equipment. A considerable amount of clearing and fencing was done, two new wells were drilled, and the entire water system was greatly improved. In this work 102 unskilled laborers and 48 mechanics were employed.

Other construction work under the emergency appropriation included cattle and milking barns at the Ardmore, S. Dak., field station, and a milking barn at the Woodward, Okla., field station.

THE RESEARCH LABORATORIES

The work of the research laboratories, which includes research on dairy products and on the nutrition of dairy cattle, is under the direction of L. A. Rogers.

NUTRITION OF DAIRY COWS

MINERAL METABOLISM

The investigations on the mineral requirements of cows giving a relatively large volume of milk have been continued. The bureau now has cows that for a number of years have been on rations some of which are presumably deficient in available minerals. Certain consistent tendencies among these animals have been observed. In general, the animals fed for long periods on rations of grain and poor timothy hay as the sole roughage have either died prematurely on such rations or have become useless through failure of the reproductive function; but animals fed on rations of grain with either good alfalfa or good timothy hay have kept in sound health, and reproduction has been satisfactory. A few animals, after being kept for a long period on grain and on either timothy or alfalfa hay alone, were changed to a ration of grain and a combination of good alfalfa and good timothy with excellent results; not only have their health and reproduction been satisfactory, but the milk yield has been decidedly higher than when they were limited to either kind of hay as the sole roughage.

The experiments in mineral balances of cows on different rations have shown that the calcium balance, and sometimes the phosphorus balance, is distinctly better on a ration containing No. 1 timothy than No. 3 timothy.

It has been established that the form in which calcium is furnished is of importance in determining its availability. Cows on normal rations and giving a large milk yield were kept in positive calcium and phosphorus balance by feeding supplements of monosodium or disodium phosphate.

On account of the expense and time consumed in carrying out feeding experiments with cows, an attempt has been made to use white rats for certain phases of this work. Although rats do very well for certain purposes, they have not been entirely satisfactory for this work when fed rations containing a large proportion of hay in any form. They have been carried to the third generation, but growth and reproduction have not been entirely satisfactory.

Rabbits have a digestive system better adapted to rations containing a large proportion of roughage and will be used for this type of work.

PROTEIN METABOLISM

The amount of protein required by dairy cows for maintenance, growth, and milk secretion depends on the kind of protein fed. It is not practicable at present to use cows in refined experiments

on the value of different kinds of protein on account of the expense of the rations required. The protein work may, therefore, be divided into comparatively rough general work on cows and more refined work on rats.

There are conflicting views as to the amount of protein which will best maintain the milk yield. The results obtained in the first year's investigation have not been conclusive; they indicate that the nutritional condition of the animal may frequently lead one to misinterpret results brought about by abrupt changes in the level of feeding protein. It is possible that some cows may have a greater ability to draw on the reserve protein of their bodies than others. Further work on this problem is under way.

The nutritive value of the various amino acids of which proteins are composed is being determined by feeding experiments with rats. Results of work on valine and isoleucine in the last year indicate that these are not essential for maintenance, but conclusions could not be drawn in regard to growth. The experiments were impaired somewhat by the unpalatability of the gelatin which was an essential part of the ration. An attempt is being made to prepare a hydrolysate of the gelatin which will eliminate the objectionable features but retain all its amino acids. Similar work has been carried out to determine in which of the amino acids corn meal is deficient. It has been found that when corn meal was fed as the sole source of protein in amounts constituting up to 89.5 per cent of the ration, growth was limited. Growth was greatly accelerated by adding casein to the ration, but it was not aided by adding tryptophane, which indicates that this amino acid is not the limiting factor as has been assumed.

In preparation for nitrogen and sulphur-balance experiments with rats, analytical methods are being developed for separating the feces, urine, feed, and sloughed-off hair and skin.

In the work on protein metabolism it is necessary to know the chemical properties of the amino acids and methods of preparing them in a pure form. Considerable progress has been made, particularly on the oxidation of cysteine, and a number of papers have been published giving the results of the experiments.

VITAMINS IN FEEDS

The vitamin content of feeds has usually been considered in relation to its influence on the vitamins in the milk. It is evident, however, that the accessory factors may, under certain conditions, have an important part in the metabolism of the cow. The work on this problem with grain has included a study of the B₂ factors in corn meal. The results so far obtained indicate that corn meal contains sufficient of all but one of the B factors. The relative amounts of vitamin A in alfalfa hay and timothy hay and in alfalfa cured under different conditions have been determined. It was found that good alfalfa contains 10 to 30 times as much vitamin A as does good timothy hay. There is also a very great difference between alfalfa protected from the sun while curing and that exposed to the sun and rain in windrows; the vitamin A content of the former was found to be 4 or 5 times that of the latter.

BACTERIOLOGY AND CHEMISTRY OF MILK

It was formerly assumed that the preservation of evaporated milk, in common with other canned food, depended upon complete destruction of all bacteria, including those in the spore stage. It is now known that this is not necessarily true and that spores in milk may survive the most rigid commercial sterilization methods. Ordinarily these spores do not germinate and the quality of the milk is not affected by their presence, but under certain conditions they grow and the milk spoils. Examination of the milk soon after the spoilage, however, may fail to reveal the presence of any viable bacteria. In order to understand and correct these conditions the factors that control the formation and germination of bacterial spores are being studied. Work in the last year on the effect of storage at a wide range of temperatures and under both wet and dry and alternate wet and dry conditions has shown that in certain species most of the spores do not survive very long when left in contact with the products of growth, but a very small percentage may survive for a long time and germinate normally.

Technical papers on the effect of surface tension and osmotic pressure on the germination of spores have been published by bureau investigators.

Since the demonstration of the efficacy of *Lactobacillus acidophilus* in controlling the bacterial flora of the human intestine, the business of supplying the public with cultures of this organism has become important commercially. *L. acidophilus* is one of a group of closely related species, and at present there is no certain method of distinguishing it from some of its nearest relatives. This is a matter of real importance, because only the true acidophilus is considered suitable for implantation in the intestine. At the request of an association of dealers in acidophilus milk, the research laboratories of the bureau have undertaken, in cooperation with other laboratories, to establish the characteristics which distinguish acidophilus from other members of the genus.

Cultures of more than 100 species, including the high-acid lactobacilli found in dental caries, as well as acidophilus and bulgaricus types, have been collected and are being studied with special attention to physiological reactions. When this work is completed it should be possible to separate the species into taxonomic groups on the basis of fundamental relations.

An extensive study was made of the oxidation-reduction potentials produced in milk by different varieties of bacteria when growing alone and in various combinations. Each species, when grown under fixed conditions, produced a characteristic oxidation-reduction potential which was usually attained coincident with the beginning of the rapid rise in numbers of bacteria.

Some of the closely related species could be sharply differentiated by their reaction to external conditions, as indicated by their oxidation-reduction potential. *Escherichia coli*, for instance, was found to bring about an oxidation-reduction system which was easily thrown out of balance by such factors as the introduction of a little air. The system produced by *Aerobacter aerogenes*, on the other hand, showed practically no sensitiveness to air. Similar differences were found among some of the streptococci, and some very interesting relations were found when dissimilar types of bacteria were grown together.

The work on fats has been limited to the two most important problems—the chemistry of fat oxidation and methods of determining the keeping quality of fats. A closed-circuit system has been devised and constructed in which oxygen can be passed through fat and the products of oxidation collected and weighed. After absorption of these products the oxygen is recirculated through the system. A number of methods have been tried for determining the oxidation-reduction potential of fats, but so far nothing has been developed that is satisfactory.

ICE CREAM

The work on ice cream mixes has included studies on the physics of the process known as aging, in which the viscosity increases and a definite structure is formed.

The results obtained indicate that in the aging the gelatin and fat interact, possibly by mutual adsorption. It will be necessary before this point can be definitely established to determine the concentration of gelatin upon the fat particles, and a special technique will have to be developed before this can be done. This work has definitely proved that homogenization can not be considered as taking the place of gelatin.

Although whipping is a very essential part of the manufacturing process, the factors which control this property are not understood. In considering this problem it is necessary to differentiate between whipping and foaming, which are not necessarily identical. Viscosity is one of the factors influencing whipping but is not the controlling factor. Experiments in which the surface tension was varied failed to show that this property had any appreciable influence on the whipping. These experiments have brought up questions of dynamic surface tension, surface viscosity, and plasticity, and the degree of adsorption at the air liquid interface and methods for measuring these properties are being developed.

The value of physical measurements on ice-cream mix is chiefly in the ability to correlate them with the properties of the finished ice cream.

In order to have similar measurements on the ice cream, a small laboratory has been constructed in which a man may work at constant temperature approaching that of the hardening room. In this room the physical properties of frozen ice cream may be determined by methods similar to those used in studying alloys. Only preliminary results have been obtained, but they are sufficient to show that they will be of great value in reducing to mathematical terms the properties which make ice cream desirable.

It is desirable, both from an economic standpoint and in consideration of the quality of the ice cream, to use relatively large amounts of milk solids not fat. The amount of milk solids that can be used is, however, definitely limited by the concentration of lactose at which crystallization takes place with the formation of so-called sandiness. Much progress has been made in methods of controlling the crystallization, but there is a certain concentration, beyond which it is not safe to go under any conditions. An attempt is now being made to perfect a method by which a large part of the lactose can be removed from concentrated skim milk before it is added to the ice-cream mix. The laboratory work on this method has given

promising results, but before they can be reduced to practice it will be necessary to get more uniform results and to try them under commercial conditions.

CONDENSED MILK AND MILK POWDER

In sterilizing milk or cream it is necessary to homogenize it to prevent separation of the fat on standing. The object of homogenization is the subdivision of the fat globules until they no longer rise under the influence of gravity, but there is also some effect, not fully understood, on the casein which lowers its stability to heat and changes its reaction to rennet. This effect is found to vary with both the temperature and pressure of homogenization. High pressures decrease the stability of cream to heat, but a second homogenization at a relatively low pressure increases the stability. On the other hand, pressures in excess of 2,000 pounds on the second homogenization increase the tendency of the cream to coagulate on sterilization. These relations have been reduced to a series of curves which are included in recent publications.

In work carried on in the last year, the existence of milk of two distinct types in relation to its reaction to electrolytes has been demonstrated. One type was rendered more stable to heat by the addition of strongly positive ions, and made less stable by the addition of strongly negative ions. The effect of these ions on the second type of milk was reversed, that is, the positive ions made it less stable and the negative ions more stable to heat. The results obtained with milks of normal solids concentration gave no indication of the effect of the same salts when added to the concentrated products.

Results on the relation of the size of casein particles in the milk to the stability of milk, obtained by centrifugal methods, have been published. This work is being continued, using other methods for measuring the size of the particles. There are reasons to believe that the potential which exists at the interface between the colloidal particles in the milk and the liquid phase of the milk may have a definite relation to its stability to heat. The measurement of this potential, especially in a fluid as complicated as milk, is a matter of great difficulty. The mechanical difficulties have been overcome, but a variable drift of the particles has continued and unless this can be overcome the method can not be used for this purpose.

Work has been started on the relation of the phospholipids to the accuracy of analyses and to the deterioration of milk powder. As a preliminary to this work it was necessary to develop a method by which the phospholipids can be accurately determined. In the course of this work it was found that discrepancy in the fat determinations of skim milk, as measured by the Babcock and Roese-Gottlieb methods, is due to the inclusion of phospholipids with the fat in the Roese-Gottlieb test. A modified Babcock test which did not include phospholipids with the fat gave correct results for milk. None of the tests, however, seems to be extremely accurate for buttermilk.

CHEESE INVESTIGATIONS

The earlier work on Swiss cheese demonstrated that there are at least three varieties of bacteria essential to the proper ripening of this type of cheese, and that the quality of the domestic cheese can usually

be improved by their introduction in pure cultures. The more recent investigations have stressed the importance of the most advantageous rate of growth, the proper numerical relation of these bacteria at different stages of the manufacture and ripening of the cheese, and the effect of one group on another. A large mass of data has been collected which gives a fairly comprehensive picture of the bacteriological changes which go on in the cheese. It has been found that while the propionic-acid bacteria are essential to proper eye and flavor development, too many of them cause what is known as oversetting. The rate of growth of this culture under different temperature conditions has been determined, and the methods of starter making have been standardized to introduce a uniform number of eye-forming bacteria into each cheese.

It has also been found that the temperature of the cheese in the press is of great importance in determining the time at which different types of bacteria begin to grow and consequently the rapidity with which acid is developed in the cheese. This in turn affects the physical properties of the cheese, the rate at which the whey drains from the curd, and the subsequent course of the ripening. Investigations are now being carried on to develop methods of controlling the temperature during pressing.

In the last year more than 3,000 packages of cultures of bacteria for use in the manufacture of cheese were distributed to factories. Getting liquid cultures to the factories at just right stage for the most satisfactory results has become a serious problem, and the use of a dried culture has been tried. By carefully adjusting the temperature it has been found possible to dry the eye-forming culture which is so essential in the manufacture of Swiss cheese in a spray dryer without excessive loss of numbers. In this way it is possible to standardize the powder so that the required number of bacteria for a single cheese can be put in one package and a sufficient supply for two or three weeks furnished each factory. If the dry culture is held at a reasonably low temperature the loss of vitality is slow. An effort will be made to extend this method to other cultures so that their use can be standardized and controlled.

The method of ripening Cheddar cheese in a sealed package has been brought to a point where it may be put on a commercial basis. The cheese to be ripened is pressed in a long hoop or cylinder slightly smaller in diameter than the can, and after the hoop and bandage are removed the cheese is cut into the proper length to fit the can. If the can is properly made so that the valve does not leak inwards the cheese ripens normally without molding and without swelling of the can. There is no loss of moisture and no rind. If the hoop has been properly adjusted, and the can properly made, the ripe cheese may be removed from the can without difficulty. The cost of canning is not excessive, and it is partly offset by the elimination of shrinkage and paraffining.

BUTTER

One of the greatest possibilities of increasing the consumption of butter is to increase its use as shortening in baker's cake. Commercial bakers, having displaced homemade bread very largely with baker's bread, are anxious to obtain a comparable share of the cake

business. It is generally considered that butter makes a better-flavored cake than do the other fats commonly used for this purpose. The bureau is studying the factors that influence creaming of butter, and the nature and stability of the emulsion, especially in relation to the use of butter in cakes. This work has shown that there is a narrow temperature range within which a satisfactory emulsion can be made with butter. When the factors that influence the stability have been determined an effort will be made, through adjustment of the composition of the butter or by other means, to make it possible to prepare satisfactory emulsions without undue attention to the control of temperature.

BY-PRODUCTS

CASEIN

The increase in the tariff on casein has renewed the interest of the domestic creameries in this product, and this bureau has taken up again the problem of developing efficient methods of producing a uniform and satisfactory casein for paper making. Arrangements were made with the United States Bureau of Standards for actual coating tests with casein made both commercially and experimentally. This work has indicated that the chemical tests ordinarily used for determining the quality of casein do not necessarily distinguish the caseins that produce a satisfactory coating. One of the troubles that has not yet been associated with any particular chemical composition or method of making the casein is the tendency of the casein solution to foam and cause small uncoated spots on the paper.

A method of hand coating and staining the paper to show the defects in the coat has been devised which will greatly expedite this part of the work. What is commonly known as the grain-curd method of casein making was originally devised to be used with hydrochloric acid. Some factories find it more convenient and slightly less expensive to use sulphuric acid. Many prefer to save the cost of acid entirely by using the natural sour method. The bureau has found that with proper attention to temperatures and dilution of the acid and satisfactory washing of the curd, sulphuric acid can be used in the grain-curd method. However, on account of the insolubility of the sulphates formed the use of this acid is not recommended. On the other hand, by a few modifications the natural sour method can be adapted to secure the advantages of the grain-curd method.

Some work has been done on the possibility of drying casein in a spray dryer. A very fine soluble casein can be made in this way, which may be suitable for certain purposes but on account of its physical properties is not adapted to paper coating.

LACTOSE

The simplified method of making lactose previously reported as having been developed in the laboratory has been given a thorough trial under commercial conditions. It has been necessary to make a few modifications, usually in the direction of simplification. The process is now ready for factory operation. With this method the

sugar is crystallized from either sweet or acid whey without first removing the proteins, which is an essential step in the usual process. A sugar of sufficient purity for food purposes may be obtained on the first crystallization, but if a high degree of whiteness is required the yield must be reduced or the crude sugar purified and recrystallized. This sugar may be converted into the beta form by dissolving and drying on an atmospheric drum dryer.

ALBUMIN

For years efforts have been made to find ways of commercially recovering the albumin of milk, a valuable food substance, without altering any of its chemical or physical properties. The albumin exists in solution in the milk with the milk sugar and mineral salts. The problem has been to remove the albumin from the milk without altering its properties and also to free it from the associated substances. An effort has been made to remove by electrodialysis the salts from a whey of relatively low lactose content. To accomplish this several cells have been constructed and operated, and many mechanical difficulties encountered in a cell large enough to even approach commercial possibilities have been overcome. Experiments will be made in making a soluble albumin with a low ash content in sufficient quantities to determine its value in modified milk, cooking, and for other uses.

LACTIC ACID

A continuous method of making lactic acid by fermentation of whey, developed in the laboratories, has been tried on a small commercial scale and found to work very satisfactorily. By this method the whey or other fermentable material flows slowly but continuously through a tank in which an active lactose-fermenting culture is maintained under optimum conditions of temperature and chemical reaction. This has the effect of an infinitely rapid transfer of the culture into fresh material and maintains the fermentation at its maximum speed. The sugar is completely or almost completely fermented in its passage through the tank, and the acid may be easily removed in the form of calcium lactate. At the present time, however, there is not sufficient demand for lactic acid to warrant a dairy manufacturing establishment in installing this process.

NUTRITIVE VALUE OF DAIRY PRODUCTS

BUTTERFAT

In an investigation maintained at the University of California, partly on funds supplied by this bureau, results which open a new field in nutrition have been obtained. As this investigation develops it is expected that it will show that butterfat has peculiar nutritive properties not possessed by other fats. Incidentally it shows the importance of studying the significance of the individual constituents of milk in nutrition.

LACTOSE

Although much has been written in recent years about the value of lactose in controlling the bacterial flora of the human intestine,

very little is known about the nutritive value of the sugar. Feeding experiments with animals are under way to determine whether there is a difference in the tissue formed with lactose and saccharose as the major sources of carbohydrates in the ration. In preliminary experiments with rats there was a distinctly greater tendency to lay on fatty tissue when saccharose was fed than was the case with lactose. However, in this experiment it was not possible to control the amount of the ration eaten, and the investigation is being repeated with the energy intake carefully controlled. Both rats and pigs are used in this experiment.

BREEDING, FEEDING, AND MANAGEMENT INVESTIGATIONS

This work is carried on by the Division of Breeding, Feeding, and Management Investigations, under the direction of R. R. Graves.

THE BREEDING HERD AT THE UNITED STATES DAIRY EXPERIMENT STATION AT BELTSVILLE, MD.

PROGRESS OF LINEBREEDING-OUTBREEDING PROJECT WITH HOLSTEIN-FRIESIAN CATTLE

The information on the milk and butterfat producing ability of the foundation cattle used on this project is now complete. There were 41 foundation females, 34 of which completed 55 milk and butterfat production records under standardized conditions of milking, feeding, and handling. These 55 records when corrected to a mature-age basis average 19,363 pounds of milk and 666 pounds of butterfat. Considering only the best record of each animal, the 34 cows average 19,873 pounds of milk and 679 pounds of butterfat. Of the 41 foundation cows, 19 are represented by female progeny in the first outbred generation, and only 15 of these foundation cows have female descendants in the second outbred generation.

In the first outbred generation, 31 daughters of Denton Colantha Sir Rag Apple have completed first-calf records, averaging 14,366 pounds of milk and 492 pounds of butterfat.

In the second outbred generation, 14 normal daughters of the proved sire Varsity Derby Matador have finished first-calf production records which average 15,958 pounds of milk and 556 pounds of butterfat.

In the third outbred generation, three of the nine daughters of the proved sire Pride of the Bess Burkes are now on test. This sire is dead, and this group is limited to his nine daughters.

They are being mated to a fourth proved unrelated sire, Count Piebe Hengerveld Ormsby, to produce a fourth outbred generation.

The first linebred generation, which now numbers 12 females, is being produced by mating Sir Gerben Colantha Rube (a son of Varsity Derby Matador out of a daughter of Denton Colantha Sir Rag Apple) to daughters of Denton.

For the second linebred generation Pride Ormsby Gerben Colantha Ona (a son of Pride of the Bess Burkes out of a daughter of Varsity Derby Matador) is being mated to daughters of Varsity Derby Matador.

In the last year five inbred daughters of Varsity Derby Matador were added to the herd by mating him to his own daughters.

PROGRESS OF INBREEDING-OUTBREEDING PROJECT WITH JERSEY CATTLE

Most of the foundation cows of the Jersey herd are gone, and as the remaining females are mostly descended from previous herd sires, the three groups may now be designated as the Owl-Interest, the Sophie-Tormentor, and the Raleigh groups.

The Owl-Interest group consists of 13 outbred and 2 inbred daughters of The Moose O'Fernwood, 2 outbred and 5 inbred daughters of Double Moose of Sophieson (an inbred son of The Moose O'Fernwood), and 5 outbred and 7 linebred daughters of Oxford May's Interest Owl, the Owl-Interest sire now in service. Both preceding sires are dead.

The Sophie-Tormentor group is now made up of 3 outbred daughters of Hood's Sophie's Tormentor, 10 outbred, 5 inbred, and 4 linebred daughters of Sophie's Torono 23d. Both of these sires are dead, and Sophie's Phoenix, a proved, linebred Sophie-Tormentor bull, is now in service in this group.

Four mature daughters of Sophie's Torono 23d completed mature records during the fiscal year, ranging from 648 to 794 pounds of butterfat.

The Raleigh group is now made up of 3 outbred daughters of Karnak's Noble 4th, 7 outbred and 2 linebred daughters of Tiddledywink's Raleigh, and 3 outbred and 1 linebred daughters of Raleigh's Dorothy's Senator, the present sire in this group.

All daughters of Tiddledywink's Raleigh have now completed 2-year-old records, and the 10 average 9,583 pounds of milk and 541 pounds of butterfat at 2 years and 2 months of age. A daughter of Karnak's Noble 4th completed a record of 815 pounds of butterfat during this fiscal year.

PROGRESS OF FAMILY CROSSING EXPERIMENT WITH JERSEY CATTLE

This project progresses slowly because of the small groups of foundation females involved, but animals representing the combinations of eight or more families are now being dropped in the herd. Corresponding reductions are being made in the older generations. There are now 3 females and 3 males of 2-family combinations, 18 females and 5 males of 4-family make-up, 6 females and 2 males represent 6-family ancestry, and 5 females and 4 males are descended from 8 different families.

OFFICIAL TESTING

The usual program of official testing for milk and butterfat under standardized conditions was followed. These tests are made in order to get comparable records on all animals in the experimental herds. During the year 13 mature Jersey cows made records averaging 12,555 pounds of milk and 655 pounds of butterfat, and fourteen 2-year-old heifers averaged 8,933 pounds of milk and 488 pounds of butterfat. When these are included with previous records, the grand average for 145 records completed by 104 cows was 10,054 pounds of milk and 546 pounds of butterfat, at an average age of 3 years and 10 months.

Seven mature Holstein cows completed records averaging 18,934 pounds of milk and 646 pounds of butterfat, and 14 first-calf heifers (one aged 3 years and 1 month) averaged 15,134 pounds of milk and 530 pounds of butterfat. This brings the total number of Holstein official records to 123 made by 83 cows, averaging 16,468 pounds of milk and 569 pounds of butterfat at an average age of 3 years and 10 months.

PROVING BULLS

Sixteen new names were added to the list of farmers and other co-operators who are proving dairy bulls from the Beltsville herd. Eleven young Holstein bulls were placed with new and old co-operators, and 5 others are promised, making a total of 65 bulls in service or engaged. Five of these are in the herds of cooperating colleges or experiment stations. Nine young Jersey bulls placed during the year bring the total number for this breed in service to 50, and 3 others are promised. Seven are in college or experiment-station herds. A number of exchanges of bulls among co-operators was effected, and cooperation was discontinued in several herds. Four bulls died, and 7 were slaughtered during the year.

Enough records were compiled during the year to afford evidence of the transmitting ability of 7 Holstein sires. The daughters of 6 of the 7 showed average increases in milk production of 208 to 2,120 pounds, and increases in butterfat of 29 to 89 pounds (over the production of the dams of the daughters). Only 1 of the 7 had daughters which produced less milk and butterfat than their dams.

Data accumulated during the year on 8 Jersey sires show that the daughters of 7 of these sires averaged from 6 to 109 pounds more butterfat than the dams of the daughters, and the other sire's daughters averaged 21 pounds of butterfat less than their dams.

These 15 sons of proved herd sires at Beltsville are themselves proved sires, and the great majority of them have given proof of possessing the hereditary make-up which enables them to improve production in the herds in which they have been used.

From the bulls proved at Beltsville, herd sires were selected for the field stations at Mandan, N. Dak., and Jeanerette, La., and two others were lent to the West Tennessee Experiment Station at Jackson, Tenn., and the Tennessee Junior College at Martin, Tenn., on cooperative dairy-cattle breeding experiments.

HEALTH AND FERTILITY STUDIES IN THE BELTSVILLE HERD

BREEDING EFFICIENCY

In the abortion-negative herd, 143 females were bred during the fiscal year, and 117, or 81.8 per cent, conceived. Of 67 females bred in the abortion-positive herd 45, or 67.2 per cent, conceived. All heifers bred were in the negative herd, and they had a lower percentage of conceptions than the cows.

CALVING EFFICIENCY

A total of 103 pregnancies in the abortion-negative herd during the fiscal year terminated in 89 normal calves, 11 dead calves, and 3 abortions; while in the abortion-positive herd 46 pregnancies

resulted in 35 normal calves, 3 dead calves, and 8 abortions. The abortions in the negative herd amounted to 2.9 per cent, and in the positive herd 17.4 per cent.

STERILITY

In the abortion-negative herd 7 animals were disposed of because they were considered permanently sterile, and in the abortion-positive herd 8 were disposed of for the same reason.

Six cases of delayed oestrus were treated by removal of persistent corpora lutea, and 2 of the subjects conceived on first service, 2 on second service, and 1 on third service after removal. In the remaining case conception did not occur.

Two temporarily sterile animals treated with injections of filtered urine from pregnant women and with olive-oil extract of urine from pregnant cows became pregnant 33 and 49 days after treatment stopped.

FERTILITY STUDIES IN MALES

Sixty-six samples of semen taken from herd sires and experimental bulls were examined during the year, and the studies of the effect of exercise and the feeding of sprouted oats upon fertility in the male were continued.

BOVINE OVA

In order to study the developing fertilized bovine egg, three cows were slaughtered, one 48 hours after mating and two 72 hours after. This work is in cooperation with the Carnegie Laboratory of Embryology, at Baltimore, Md. In this work one unfertilized egg was recovered; one fertilized ovum was found, which was cultured to the 2-cell stage; and the other cow did not ovulate.

RELATION OF THE CONFORMATION AND ANATOMY OF THE DAIRY COW TO HER MILK AND BUTTERFAT PRODUCING CAPACITY

ANTE-MORTEM AND POST-MORTEM STUDIES

This work involves the measurement of the conformation and the anatomical study of cows of known producing capacity. Eighteen State experiment stations are cooperating on this project.

Ante-mortem and post-mortem reports on 48 cows were obtained during the fiscal year. Of this number, 21 were prepared at the Beltsville station, 13 were received from Clemson College, S. C., 5 from Pennsylvania State College, 4 from the University of Florida, 2 each from the University of Nebraska and Utah State College, and 1 from Michigan State College. The total number of ante-mortem and post-mortem reports on cows with production records now on file is 334. Of this number, 98 were prepared at the Beltsville station, 78 were submitted by Pennsylvania State College, 48 by Cornell University, 35 by Clemson College, 11 by the University of Missouri, 11 by the University of Florida, 8 by the University of Nebraska, 7 by Michigan State College, 6 by Utah State Agricultural College, and 5 or fewer by each of 10 cooperating stations. Anatomical studies of 3 bulls were also made at the Beltsville station during the year.

THE MAMMARY GLAND

For several years a systematic study of the udder has been conducted at the Beltsville station. The plan of this experiment has been given in previous reports. Post-mortem studies of 33 amputated udders were made during the year. Udder capacities were determined for 15 lactating cows, 12 nonlactating cows, and 4 calves. To date the total number of udders for which capacities have been measured is 92. Thirty-four of these were lactating and held an average quantity of fluid equivalent in volume to 40.41 pounds of milk, and 30 nonlactating udders had a capacity of 25.77 pounds. The udder capacity of 7 heifers averaged 9.26 pounds, that of 2 freemartins averaged 5.05 pounds, that of 11 calves of various ages averaged 0.28 pound, 1 nonlactating Aberdeen Angus had an udder capacity of 8.23 pounds, and 7 experimental Hereford cows had capacities averaging 6.1 pounds. Post-mortem milking studies were made with 4 amputated udders. Thirty-one udders were frozen, sectioned, and photographed, and histological studies were made on 23 of these. This makes a total of 110 udders that have been sectioned and photographed and 79 that have been studied histologically. The ante-mortem capacity of 2 cows has been determined by injecting milk through the teats into the udder and measuring the quantity it would hold. In this work the pressure used was the same as that used in measuring the capacity of amputated udders. The udders of 4 calves ranging up to about 7 months of age have been studied by dissecting out one half and sectioning the other half. The dissections are particularly instructive, as they show clearly the different stages through which the calf udder passes during development. Three papers covering post-mortem milking studies have been completed, and the results obtained with seven experimental Herefords kept under dairy-herd conditions have been partly prepared for publication.

CONFORMATION AND GROWTH

Photographs, measurements, and contours, designed to show the conformation of animals at different stages of development and after maturity, are taken regularly. This work has been continued along the lines described in previous reports. Many areas, volumes, proportions, and factors based on the interrelations of the body measurements have been determined for the animals measured.

OTHER ANATOMICAL STUDIES

Measurements of the diameter as well as the weight and length of intestines were made for 21 cows and 3 bulls slaughtered in connection with anatomical studies. Additional work has been done to measure the rate of passage of feed through the digestive tract, in an effort to determine the significance of length or diameter of intestines.

The study of the rate at which individual cows release their milk when milked by machine has been continued. During the year 46 cows were "timed" at least once. Some of the cows were timed on successive months of lactation. The results with individual cows

varied greatly. Rate of release will be studied in relation to the history of development of the udder, its size, shape, and other characteristics, its producing capacity, and the gross and microscopic structure and physical properties of the tissue as determined on post-mortem examinations.

FEEDING AND MANAGEMENT INVESTIGATIONS AT THE BELTSVILLE, MD.,
EXPERIMENT STATION

THE CONDITION OF A COW AT CALVING TIME

The object of this work is to determine the effect of condition of the cow at calving time upon the quantity of milk and butterfat produced after calving, and to find out whether it is an economical practice to have cows fat at calving time. The plan is to have them fat at one calving, thin at the next, and fat at the third, or the reverse; that is, thin, fat, and then thin. On account of the fact that the cows are used on other work which does not permit comparable feeding and handling for the entire lactation period, the records after calving are taken only for the first 90 days.

There are 13 cows on this work. Eight of these have calved twice, once when fat and once when thin. Seven of the eight produced more milk and butterfat after calving in a fat condition than after calving in a thin condition. At the end of 90 days, 6 of the 8 were producing more after calving when fat than after calving when thin. There was no uniformity in the time required for a cow to reach the peak of her production traceable to the matter of condition. Five of the eight reached a greater peak in production following the calving when fat. Two of the cows that had excessive congestion of the udder after calving in a fat condition had no such trouble after calving in a thin condition. On the other hand, two of the thin cows retained their afterbirths. The details of this work, when completed, will be reported in another publication.

BEDDING MATERIALS

Peat moss was compared with other bedding materials in different kinds of stalls and in calf pens. Although peat moss is much superior to other bedding materials in its ability to absorb liquids, it seems that in practice the matter of bulk has as much to do with the quantity used as does the liquid-holding capacity. With cows in box stalls, the average quantity of peat moss used per cow per day was 14.3 pounds; of wheat straw, 17.2 pounds. When the bedding was confined to a space 4 by 7 feet in box stalls, 10.9 pounds of peat moss were used and 13.4 pounds of wheat straw. In ordinary stalls with stanchions and gutters, the following quantities of several materials were used per cow per day: Peat moss, 7.1 pounds; wheat straw, 3.2 pounds; wood shavings, 8.6 pounds; buckwheat hulls, 7.4 pounds. As compared with wheat straw, relatively more peat moss was used in the ordinary stalls than in box stalls. The reason for this was because there was no provision in the ordinary stalls to prevent its slipping into the gutter and becoming soiled. In calf pens an average of 2 pounds of peat moss was used per calf per day as against 2.1 pounds of wheat straw. Flies bred as readily

in the soiled peat moss as in the soiled straw. This finding is not in agreement with statements made by some dealers in peat moss. At the prices paid for bedding, wheat straw was the most economical material used.

THE CONTENT OF MOISTURE REQUIRED TO PRESERVE CORN IN THE SILO

During the drought of 1930 the question arose as to the quantity of moisture necessary to preserve silage. Samples taken from different places in a silo at the Lewisburg, Tenn., Dairy Experiment Station showed moisture contents of 57, 59.8, and 64.4 per cent. Although the silage where these samples were taken was in good condition, there had been an abnormal amount of spoilage elsewhere in the silo. Silage was made at Beltsville, Md., from drought-stricken corn at different stages of dryness. The driest corn used contained 66 per cent moisture which in this instance was sufficient for preservation. This corn carried no ears and was much drier than is usually the case when cut for the shock.

FEEDING COTTONSEED MEAL TO DAIRY CATTLE

All the young calves fed cottonseed meal at Beltsville have died before they reached the age of 100 days. In most cases the calves have appeared normal up to within a day or two of death. In some cases death was preceded by convulsions. The only condition common to all the calves that died, as shown on autopsy, was a straw-colored material in the thoracic cavity.

Several calves have been fed the milk from cows that received 10 pounds of cottonseed meal a day and a good roughage without bad effects, except possibly a small decrease in the rate of gain.

Two cows are being fed cottonseed meal and wheat straw to bring about the so-called cottonseed-meal injury. The meal used is a part of the same lot fed to the calves with fatal results. After eight months of such feeding the cows are still in good health, and there has been no symptom of vitamin A deficiency or any other trouble. Both cows carried normal calves for the full gestation period. However, the milk yield since calving has been less than two-thirds of the quantity that would be expected on a usual ration.

Two other cows were fed cottonseed meal at the rate of 10 pounds each per day, along with all the alfalfa hay they would eat for about six months, to find out whether heavy protein feeding, especially of cottonseed meal, would cause garget. One cow gave milk with a normal number of bacteria and leucocytes. The other cow started on the experiment giving milk with a rather high count of leucocytes and bacteria, mostly streptococci. The counts varied up and down for the whole time, generally being above normal, but at the close of the experiment they were lower than at the beginning. Neither cow showed any outward evidence of udder inflammation at any time. The completed work, of which the above is a part, will be reported in another publication.

DEHYDRATED HAY

A mixture of alfalfa and clover cured by chopping freshly cut hay and running it through a hay drier, was fed in comparison with No. 1

alfalfa hay cured in the usual way. Eight cows were fed for 124 days. The cows fed the dehydrated hay declined in milk flow a little faster and gained more in weight than the others. In view of the fact that the dehydrated hay contained much clover which is probably not so valuable as alfalfa, it appears that the dehydrated hay made a favorable showing.

In another experiment three cows were fed dehydrated soybean hay as a sole ration for three to five months. They ate 30 to 45 pounds of hay a day after they freshened, and produced about as many pounds of milk as pounds of hay eaten. All of the cows became thin, indicating insufficient nutrients. In previous lactations these cows had been fed rations containing liberal quantities of grain and medium quantities of roughage. As they were not accustomed to a ration of roughage alone they ate somewhat less than they might have eaten otherwise. The experiment is useful in showing that cows will eat enough hay of good quality so that the allowance of grain may be reduced somewhat below the quantities usually fed. One cow changed from a ration containing much grain to one of dehydrated soybean hay alone, refused to eat and would apparently starve herself to death with good, wholesome hay right in front of her. Another cow behaved similarly on dehydrated alfalfa after a few months feeding. Still another behaved as the first when fed No. 1 chopped alfalfa hay as the sole ration. No doubt the rations to which these cows had been accustomed throughout their lives had a great deal to do with their peculiar behavior when fed a ration of hay alone.

The content of inorganic phosphorus in the blood of these cows varied from 2 to 3.9 milligrams per 100 cubic centimeters of blood as compared with a normal of above 5 milligrams. Another cow, which was fed No. 1 chopped alfalfa hay and had recently freshened, had an inorganic phosphorus content in the blood of 4.1 milligrams. These deficiencies in phosphorus, should they be continued, may indicate the desirability of supplementing the hay ration with some material rich in phosphorus, as wheat bran, or bone meal.

INDIVIDUAL FEEDING COMPARED WITH GROUP FEEDING

Twelve heifers and dry cows in 2 groups of 6 each were fed by the reversal method for 60 days. The animals of one group were confined in stanchions, those of the other group were allowed to run loose in a pen. At the end of 30 days the feeding of the two groups was interchanged and the experiment continued for another 30 days. Alfalfa hay was fed up to capacity. The quantity of hay refused was the same for both groups. The grain was fed individually in all cases, and the quantity offered each animal remained unchanged for that animal throughout the experiment. The animals fed in a group ate on the average 16.2 pounds of hay per head per day and gained 1.49 pounds; those fed individually ate 16.1 pounds of hay and gained 1.03 pounds. The reason for this difference in gains can not be explained. Some observations made at Beltsville previous to this experiment indicated that cows and heifers fed as a group consumed considerably more hay than when fed individually. The results of this experiment failed to confirm these observations.

COOPERATIVE PASTURE INVESTIGATION

The drought during 1930 was one of the worst ever experienced in the Beltsville section, the rainfall for the six months, April to September, inclusive, being only 8.7 inches. The grass in all the pastures practically stopped growing about June 15. It is estimated that the different pastures on this investigation yielded the following amounts of digestible nutrients per acre in 1930:

	Pounds
Fertilized, rotation grazed (Hohenheim)-----	1,868
Fertilized, continuously grazed-----	1,603
Unfertilized, continuously grazed-----	1,142
Reed canary grass-----	878

The pasture on which rotation grazing was practiced yielded 265 pounds, or 17 per cent, more digestible nutrients than did the pasture grazed continuously. It appears that this greater yield would, if continued over a number of years, more than pay for the additional fencing required to divide the pasture into a number of fields.

The continuously grazed pasture that was fertilized yielded 461 pounds, or 40 per cent more digestible nutrients than did the unfertilized pasture. The fertilizer cost \$12 per acre. The 461 pounds of digestible nutrients could be bought in hay valued at \$27 a ton for about the same amount as the fertilizer cost. The fertilized pasture comes on a little earlier in the spring, has a better color, and more completely covers the ground. It is thought that the benefits from fertilizing will be more pronounced in a season of normal rainfall. Also, as time goes on, it is probable that the differences between the fertilized and unfertilized pastures will become greater.

The Reed canary grass pasture which was unfertilized and continuously grazed produced somewhat less than the grass mixture similarly grazed and treated. The stand of canary grass is thin because the amount of seed used was small and there has been insufficient rainfall since seeding for it to thrive.

SEASONAL GROWTH OF PASTURE GRASS

Plots of pasture grass were fenced off and clipped with a mower to a height of about 2 inches at intervals of 10 days or more throughout the growing season. In May the grass may grow fast enough for 1 acre to well support a cow. In July and August, 15 or 20 acres may be needed to provide the same quantity of grass as 1 acre in May. The slow midsummer growth is followed by a partial revival in the fall. The bureau's pasture work at the Beltsville station indicates clearly the necessity for supplementing the pasture with grain or other feed rather early in the season. One of the most important problems in pasture management is to devise some way of providing good grass in midsummer.

WORK AT THE FIELD EXPERIMENT STATIONS

MANDAN, N. DAK., STATION

The section of grazing land acquired last year has been fenced and is being used for pasture. Approximately 30 acres of the bottom land in the coulees has been seeded to alfalfa and is being cut for hay.

Experimental work has been started with a straw-pen barn to get information on the utility of this type of barn as an inexpensive shelter for dairy cattle. This particular barn is 70 by 40 feet and is designed to house 40 cattle. The roof and side walls are built of straw with wire netting to hold it in shape.

Data have been obtained on the comparative yields and feeding value of barley and oat hay as compared with alfalfa hay.

The milking barn was remodeled and a machine-milking system installed. All the herds at the field stations are now milked in the same manner, and it is thought that the records made for inheritance and feeding studies will be on a more comparable basis.

The Holstein herd was increased by the addition of six heifers transferred from the Woodward, Okla., station. A new proved herd sire, Sir Colantha Old Inn Hero 488066, was recently sent to Mandan. He was bred at Beltsville and was proved in a Pennsylvania institution herd.

HUNTLEY, MONT., STATION

Twelve head of Holstein cattle from the Huntley station were exhibited at the National Dairy Exposition at St. Louis, Mo., in October. The purpose of this exhibit was to show the progress made in the proved-sire breeding experiments that have been under way at the Huntley station for several years. Much interest was shown in this exhibit, especially in the breeding or genetics school held in connection with it. Many dairy specialists and heads of dairy departments of the State colleges of agriculture, county agents, breed field men, etc., attended the school.

A 40-cow pen barn was built to accommodate the enlarged herd. Data are being obtained on barn temperatures and the amount of bedding required for barns of this type.

Thirteen additional acres were seeded to permanent irrigated pasture, and 35 acres were put under irrigation and seeded to alfalfa.

Feeding cows for extended periods on alfalfa hay alone is being continued.

Three sires were proved during the year. One was sent to the South Carolina State Agricultural Experiment Station, one to the Utah State Agricultural Experiment Station, and another to the Western Washington Agricultural Experiment Station at Puyallup.

ARDMORE, S. DAK., STATION

Grain hays grown on the station farm are being used in feeding experiments to compare their feeding value with alfalfa hay.

The winter was an extremely mild one, and practically no ice was formed in the experimental ice well which was constructed in 1930 to get data on the value of ice wells for dairy farms in this region, supplementing experiments with an ice well at Mandan.

A new cow barn to hold 40 cows and a milking barn have been built. The cow barn is of the shed type and has no stanchions, having simply a large feeding rack in the center. Grain will be fed in the milking barn.

WOODWARD, OKLA., STATION

Experiments on feeding cows for extended periods on alfalfa hay alone were started. Three cows are now on this experiment. These cows are consuming extremely large amounts of hay, and their milk production is holding up remarkably well. In 197 days, cow W44 has consumed 9,466 pounds of hay, averaging almost 50 pounds per day. In that time her milk production was 8,703 pounds of milk, or an average of 44 pounds per day. Her initial body weight was 1,120 pounds, and at the end of 197 days her body weight was 1,077 pounds, a loss of only 43 pounds. Cow W21 has consumed an average of 51 pounds of hay per day for 188 days and has produced an average of 55 pounds of milk per day. Cow W47, in 131 days, has consumed an average of 45 pounds of hay per day and has produced an average of 45 pounds of milk per day.

Yields of Sudan hay cut at three stages of maturity (first heads out, fully headed, and milk or soft dough) compared favorably with yields obtained in previous years. In these experiments, the first-heads-out hay was about equal in yield of cured hay per acre to that of the hay cut at the other two stages of maturity and contained more crude protein than fully headed hay and soft-dough hay.

A new milking barn containing eight milking stalls was built.

The first daughters of the proved bull King Paul Helena Walker 348317, are completing their first official records. They are producing materially better than their dams, which were inbred to the Count Piebe Watson bull.

JEANERETTE, LA., STATION

Arrangements have been made for a division of the land at this station. This will materially increase the pasture and cropping area, and plans are now being made to extend the pasture investigational work.

The herd sire, Pogis Torono Investigator 177267, died of injury during the year and was replaced by The Moose of Olga Lad 252894. The latter bull was bred and proved at the Beltsville station.

PONTIAC, S. C. (SANDHILL) STATION

The foundation Guernsey herd at this station was increased by the purchase of 11 bred heifers. These heifers are all sired by proved sires.

An area of approximately 6 acres in the main pasture was measured off and fenced, and data on the carrying capacity in terms of milk production per acre are now being obtained.

Two bull barns, a heifer barn, and a calf barn were built by the South Carolina State Agricultural Experiment Station. The State station is cooperating in the work at the Sandhill station.

Approximately 10 acres have been seeded to pearl millet to obtain information on its value for pasture for use during the season when the main pasture is likely to be dried up. Also crops will be sowed for late fall and early winter pasture.

LEWISBURG, TENN., STATION

Work on improving and developing the station farm is progressing. The opening field day, attended by several thousand people, was held in May. Much interest was shown in the breeding experiments, the hay drier, and other experimental work in progress.

The hay drier has been running steadily, and freshly cut oats, soybeans, rye, Sudan grass, and other green forage have been artificially dried. Experiments have been started to compare the feeding value of the artificially dried materials with those cured under field conditions.

A proved Jersey sire, Holger St. Mawes Noble 230503, was purchased in November and is now in use at the station.

HANNIBAL, MO., STATION (THE HATCH FARM)

Ten head of foundation Jersey heifers were purchased for this station in January. These heifers are all sired by proved sires. A proved herd sire, Ayerdale's Exile 197339, was shipped there. This bull was bred at the Beltsville station and was used and proved at the West Virginia State Agricultural Experiment Station for a number of years.

MARKET-MILK INVESTIGATIONS

This work, which is conducted by the Division of Market-Milk Investigations, is under the direction of Ernest Kelly.

The routine work of the division was carried on as formerly. This included students' milk-judging contests, inspection and bacterial counts at the bureau's experiment station at Beltsville, Md., and the monthly inspection and bacterial control at the United States Naval Academy dairy at Gambrills, Md. The Naval Academy dairy continues to be conducted along very high sanitary lines; the average bacterial count for the mixed milk for the year was extremely low, only 3,650 bacteria per cubic centimeter.

FLY CONTROL

Routine spraying and trapping of flies at the Beltsville station was continued with satisfactory results, and an additional experiment was made to show the relative efficiency of traps exposed to the light and traps darkened with burlap. In this experiment the undarkened traps caught about twice as many flies as the darkened ones.

WORK WITH STREPTOCOCCI IN MILK

At the Naval Academy dairy milk has been plated on blood agar along with the standard media. A limited trial has been made of the brom thymol blue dye for the rapid detection of garget. So far as the preliminary tests go this dye seems to have some possibilities.

MECHANICAL REFRIGERATION ON DAIRY FARMS

In cooperation with the Bureau of Public Roads, work was started on the study of small mechanical refrigerating systems for the dairy. Data were collected on 14 farms. The following items were taken into consideration: Full description of outfit; amount of milk

cooled; temperature to which milk was cooled with water from well; temperature to which the milk was cooled with the refrigerated water or brine; consumption of electricity; temperature at which the water in tank or air in storage was maintained; air temperature; exterior temperature of the motor case while running under full load; checking load and power factor of motor; and record of voltage on lines for 24 hours. Data have been collected on ammonia, methyl chloride, and sulphur dioxide machines. This work will be continued during the next year.

MILK SURVEY OF NORFOLK, VA.

At the request of the health authorities of Norfolk, Va., the bureau assigned a market-milk specialist for five days' work with the dairy inspectors of that city for making a survey of local conditions. Sixty-six dairies and three pasteurizing plants were inspected. At the end of the survey a memorandum on conditions found and improvements advocated was submitted to the Department of Public Welfare of Norfolk and to Virginia Polytechnic Institute.

DAIRY SANITATION

The outstanding phase of this work during the year was a resurvey of the milk supply in one area in Maine, where an extension project on quality milk had been carried out the previous year. This was a check on conditions as they existed at the beginning of the extension work. Milk coming into six shipping stations was tested by the methylene-blue and sediment tests. Extensive data were gathered on individual shippers and on the average for each plant. Marked improvement was seen at every plant. In the 1929 survey only 39.8 per cent of the milk was in grade 1, as judged with the methylene-blue reduction test, whereas in 1930 57 per cent of the patrons delivered milk in grade 1. In 1929 five of the six plants were receiving milk in grade 4, the lowest grade, whereas in 1930 only one plant was receiving any grade 4 milk. The results were very encouraging as showing the power and practicability of extension methods in bringing about the application of subject matter.

Demonstrations in methods of conducting 4-H club work on quality improvement were made at Greenville, Spartanburg, and Greenwood, S. C. Considerable interest was shown, and it is hoped that the work will go forward at these places.

Milk quality-improvement work was presented at the three Rosenswald Negro Extension Schools, with meetings at Orangeburg, S. C., Prairie View, Tex., and Nashville, Tenn. By means of these schools the milk quality-improvement project has been presented to a total of 303 negro extension workers, who represented practically the entire negro population of the South.

In cooperation with the Maryland State Department of Health and the Maryland State Extension Service, a start was made on an area quality-improvement plant in Kent and Queen Anne Counties in that State. Meetings were held in each county and were attended by town and county officials. These meetings were followed by a milk survey of the two counties which consisted of an examination of milk samples and an inspection of farms and dairy plants. This

work has led to the adoption of a milk ordinance by Chestertown, Kent County, and the starting of a 4-H club milk quality-improvement project in Kent County.

MILK-PLANT MANAGEMENT

The work of tabulating the information contained in questionnaires received from milk dealers and information collected while in the field, on the quantities of the various products handled in containers of the different sizes by plants of various capacities, has been started. Tabulation of this material is expected to give very complete data on both milk and cream as they are handled in packages of various sizes. The tabulation of these data will be by geographical sections and size of plant, and will include statistics on bulk and bottled goods—milk, cream, buttermilk, chocolate milk, special milks, etc.

About six weeks were spent in the field in making cost and other surveys of country milk-receiving stations. The bureau now has some data on about 185 such stations. The results of these surveys have been partly tabulated to show the following information: Systems of water supply; methods of sewage disposal; systems of cooling milk; relation of volume to investment in land, buildings, and equipment, where milk is shipped in tank cars or tank trucks; relation of volume of milk to investment in land, buildings, and equipment, where milk is shipped in cans; cost of labor and total operating costs per hundredweight, where milk is shipped in tank trucks; labor employed where milk is shipped in tanks; labor employed where milk is shipped in cans; and cost of labor and total operating costs per hundredweight where milk is shipped in tank cars; etc. These various plants range in size from less than 5,000 pounds to more than 40,000 pounds of milk daily and have been tabulated by size under the various headings.

EDUCATIONAL COOPERATION

Bureau specialists cooperated with the health department of one of the large eastern cities in the issuance of a publication on the production of quality milk.

They also cooperated with the Federal Board for Vocational Education in the preparation of an outline for teaching the subject of quality milk production in vocational high schools of the country.

HERD-IMPROVEMENT INVESTIGATIONS

The dairy herd-improvement investigations, which are carried on by the Division of Dairy Herd-Improvement Investigations, are under the direction of J. C. McDowell.

There were slightly fewer dairy herd-improvement associations in the United States at the end of the last fiscal year than at the end of the previous year, but there was an increase of more than 3,000 in the total number of cows on test in associations. The total number of cows in associations on January 1, 1930, was 510,714. The general economic conditions undoubtedly had much to do with preventing the gain in the association work from being larger. Some dairy

herd-improvement testing work is now going on in every State in the Union except Georgia, Florida, and Nevada.

Table 1 shows the production and income of dairy herd-improvement association cows whose records have been tabulated by the bureau each year from 1924 to 1930, inclusive, the average production of milk and butterfat per cow for each year, and the cost of feed and the income returned over cost of feed per cow.

TABLE 1.—*Summary of the steady progress of dairy herd-improvement association work showing the average increase in milk and butterfat production of cows in associations from year to year, 1924-1930*

Year	Associa- tions tabu- lated	Records tabu- lated (cow years)	Milk pro- duced per cow	Butter- fat pro- duced per cow	Average price of butterfat per pound	Gross income returned per cow	Cost of rough- age con- sumed per cow	Cost of grain con- sumed per cow	Total cost of feed per cow	Income ¹ returned per cow over cost of feed
	Number	Number	Pounds	Pounds	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
1924-----	129	32,091	7,092	279	0.58	161	37	30	1 68	1 94
1925-----	380	98,704	7,189	284	.55	156	38	29	67	81
1926-----	476	127,617	7,316	289	.59	170	39	31	69	101
1927-----	532	142,084	7,410	293	.63	184	39	33	72	116
1928-----	656	201,590	7,464	295	.66	194	39	38	77	117
1929-----	824	262,996	7,451	296	.67	197	39	41	80	119
1930-----	942	315,359	7,608	302	.64	194	39	41	80	114

¹ All cost figures in this table are based on original figures in dollars and cents.

The average butterfat production per cow in 1924 was 279 pounds, and in 1930 it was 302 pounds. The dairy herd-improvement association work was begun in 1906, and in that year the average production of butterfat per association cow was only 215 pounds. By 1920 it had increased to 247 pounds. In 1925 it was 284 pounds. In 1930 it was the highest it has ever been, or 302 pounds per cow. The gain in 1930 over 1929 was 6 pounds, one of the largest gains in recent years.

These gains have been largely due to the closer culling out of low producers and to better feeding and management. The average production is now so high that more good sires will be necessary if the average production is to be raised much higher. In order that association members and farmers in general may have available an adequate number of good sires of known transmitting ability it will be necessary to develop the herd-improvement association work in connection with proved sires far beyond its present status.

Table 1 shows that the number of records tabulated in 1930 was 315,359 in terms of cow years. As some of these cows were on test anywhere from 1 to 12 months, the number of different individual cows involved in this number of cow years was considerably more than 400,000.

The 12-month records obtained from the various associations are tabulated each year on several subjects. Among these are the relation of butterfat production to income returned over cost of feed, the relation of milk production to income over cost of feed and other factors, the relation of season of freshening to income over cost of feed and other factors, the comparison of purebreds and grades, and the relation of cost of grain to income over cost of feed and other factors. Not only are the records tabulated on each of these subjects, but they are tabulated for each State, and an analysis of each tabu-

lation is furnished to each State in those cases where there are enough records to warrant such studies. Although these are the main studies that have been reported by the bureau to the various cooperating States year after year, there are a total of 14 tabulations that are made for each State when the number of records makes such studies of value. The total number of different studies outlined to be made for the United States is approximately 60. These 60 studies include tabulations on production, on feed and feed costs, and on the various phases of proved-sire work.

The records now being received from the various States are, on the whole, much better than ever before. As the years pass, fewer and fewer records have to be discarded because they are inaccurate or too incomplete to be of use in the tabulations. This is taken to mean that the testers are, on the average, better trained or are doing their work better, and it seems to indicate that the States are anxious to submit the best records possible in order that the bureau will be able to furnish them with more complete and better analyses of the records submitted.

During the year the bureau, with the cooperation of the Bureau of Agricultural Economics, continued its survey of dairy herd-improvement work in foreign countries to find out what relation there is between the amount of herd-improvement work done and the average production per cow in those countries. It has been learned that in Denmark, the Nation which leads the world in the export of dairy products, more than 38.5 per cent of all dairy cows are on test in herd-improvement work. For Scotland the percentage is 18; for Finland, 17.4; and for several other countries the percentage ranges from 6 to 9. If we take the total number of cows in dairy herd-improvement associations and the estimate of the Bureau of Agricultural Economics for the total number of dairy cows in the country as the basis, the United States percentage is only 2.2; and if we take the latest Bureau of the Census figures for the total number of cows, the percentage is still only 2.5.

Progress was made in the cooperative bull-association work during the fiscal year. The number of associations on January 1, 1930, was 296; on January 1, 1931, the number was 359. The number of members in these associations on January 1, 1930, was 6,930; the number on January 1, 1931, was 7,037. The number of bulls in use in bull associations on January 1, 1930, was reported as being 1,280; on January 1, 1931, it was reported to be 1,609. The number of cows owned in these associations on January 1, 1930, was 44,578; on January 1, 1931, the number was 58,004. A tabulation of the production records of the bull-association cows shows an average butterfat production of 385 pounds for the dams, and an average of 414 pounds for the daughters. Here was a gain of 7.5 per cent in average butterfat production per cow for the daughters over that of their dams.

DAIRY MANUFACTURING INVESTIGATIONS AND INTRODUCTION

This work is carried on by the Division of Dairy Manufacturing Investigations and Introduction, under the direction of R. W. Bell, who was appointed chief of the division on March 1. William

White, senior dairy manufacturing specialist, was acting in charge of the division before that date.

The work of this division during the last year consisted of the following main projects: Creamery introduction, Cheddar-cheese factory introduction, introduction of the culture method of making Swiss cheese, introduction of the manufacture of concentrated sour skim milk, introduction of improved methods of making casein, supervision of the Grove City creamery, and renovated-butter factory inspection.

CREAMERY INTRODUCTION

Work under this project has consisted of instructing creamery-butter makers in all phases of creamery operation and assisting creamery managers in establishing a system of purchasing cream on a basis of the grade of butter that can be made from it. It has been carried on in Alabama, Arkansas, South Carolina, and Tennessee, in close co-operation with the agricultural colleges of these States. In Alabama, Arkansas, and South Carolina the creameries, with a few exceptions, are small and are still in the development stage. Bimonthly educational butter judgments were held in each of these three States, at which butter from the various creameries was scored for quality and composition. Those who participated are learning how to grade butter, how to make better butter, and how to control the composition. It has been estimated by the bureau that the per capita production of creamery butter in 1930 in Alabama was 0.846 pound, in Arkansas 1.506 pounds, and in South Carolina 0.258 pound. The per capita production of creamery butter for the United States as a whole in 1930 was approximately 13 pounds.

As a means of paving the way for purchasing cream on a quality basis, educational cream judgments have been held bimonthly in at least one creamery in each of these States. Cream judgments have been conducted there for three years, and the average quality of the cream received has markedly improved. This is reflected in the form of better butter on some of the markets.

Creamery-introduction work was started in Florida and a preliminary survey made near the end of the year.

In Tennessee where the creamery industry is older and better developed than in the previously mentioned States, progress has been made in improving the average quality of butter made at the creameries by means of buying cream according to grade.

In the grading method being recommended in Tennessee by the bureau the following grades are used: Premium, when the acidity does not exceed 0.2 per cent and the flavor is clean; No. 1, when the acidity is greater than 0.2 per cent but not greater than 0.4 per cent and the flavor clean; No. 2, when the acidity exceeds 0.4 per cent or the flavor is not clean.

This method was first put into practice in Tennessee in 1924 at a cooperative creamery where it has been used ever since. The success of this method of cream grading at that plant in improving the quality of butter has caused other local creameries to adopt the same or a somewhat similar grading system. Faster progress would have been made in cream grading in that State, if the creameries had been able to market their butter in such a way as to receive a greater differential between their grades of butter. This difficulty was largely

overcome for several plants when six local creameries arranged in April, 1930, to cooperate in shipping car lots of butter to an eastern market, each churning to be paid for strictly on a basis of score. Forty carloads of butter were shipped in this way, and one tub or box of each churning in every carload was scored by a bureau specialist, who immediately sent each creamery a report of its scores and criticism of its butter, together with recommendations for improvement. The creamery thus gets a quick report on its butter and knows approximately the grade and price it will receive on the market. This close correlation of quality and price has stimulated interest in improving quality and has resulted in more attention to cream grading. The net result has been better butter and better prices for every creamery participating in this project. As an example of the value which this quality-improvement work has been to cooperating creameries, six creameries which participated in the project received a total of \$36,055.77 more for 835,138 pounds of their butter than they would have received if they had not improved its quality.

The premium prices received for quality butter has enabled certain creameries to pay higher prices for butterfat. This has been an important factor in encouraging other creameries to adopt cream grading.

Monthly educational butter scorings have been held, and as many as 20 creameries have had samples of their butter at a scoring and as many as 30 people have attended.

CHEDDAR-CHEESE INTRODUCTION

The introduction of better methods of making American cheddar cheese was carried on in 13 States in the South and Middle West.

Cheese making is a comparatively new industry in a majority of the Southern States. The Bureau of Dairy Industry is paying especial attention to the States that need and want assistance. The following examples show the benefits from assistance given by bureau specialists. At one factory visited, all the cheese made during the previous four months had been of poor quality. After studying the conditions the specialists showed the factory how to modify methods to meet these conditions, with the result that the factory was able to make cheese of No. 1 quality. It was receiving 7,000 pounds of milk a day at that time. At another plant the manufacture of cheese had been discontinued because of the low quality of the product. Instruction in regard to pasteurizing milk for cheese making enabled this company to resume cheese making and obtain a high-quality product. The increase in the sale value of the cheese was at the rate of \$4,000 a year. Another factory was found to be making high-acid, gassy cheese. The trouble was found to be due to improper pasteurization of the milk and using too much starter. These errors were corrected, and the factory then made cheese that graded No. 1.

Low volume of milk is the greatest handicap of the southern cheese factory. Only a few are operating to capacity. A number of the factories were promoted by people who had little or no knowledge of the requirements, and for this reason too many large factories were built. In several localities where the daily capacity of the factories is 70,000 to 80,000 pounds of milk only 20,000 to 30,000 pounds are

received. This makes the overhead larger than it should be. A majority of the factories visited, however, are receiving more milk than they were last year.

The milk received at most of the factories is sweet enough to make a fairly good quality of cheese, if the milk is pasteurized. In the mountain sections it is practicable to use unpasteurized milk at some factories. Some localities have had considerable difficulty with onion flavor in milk. Some experimental work was done by the bureau at a southern plant to find a method for eliminating the onion flavor. Additional work is needed on this project.

INTRODUCTION OF THE CULTURE METHOD OF MAKING SWISS CHEESE

Work on this project was continued in Ohio and completed in New York. Similar work was resumed in Wisconsin early in January, 1931, previous work on this project in that State having been terminated four years ago. The culture method was developed by the bureau.

OHIO

Eighteen Ohio Swiss-cheese factories cooperated with the bureau in carrying out the culture method. Five of them had never before used pure cultures. The cultures consisted of a pure culture of *Lactobacillus casei* (39a) and an organism which seems to be a strain of *Streptococcus thermophilus* in addition to the propionic-acid-producing organism which influences the production of eyes and flavor. A combination of the first two organisms has been found to produce better cheese than when a pure culture of 39a is used alone. Late in the year pasteurization of the whey used for growing the coccus culture was adopted.

Experimental work in the Washington laboratories indicated that using an excess of eye culture tended to cause the cheese to check. The quantity used in the commercial factories was therefore reduced from 7 to 3 cubic centimeters per 100 pounds of milk. From the limited results available at the end of the year, it seems that this has been effective in reducing the amount of checking in the cheese.

Seven of the 18 factories made cheese once a day, and the others made it twice a day, except at the beginning and end of the season. The factories making cheese once a day had, on an average, cheese of better quality, than those making it twice a day. Records of previous years show that this is likely to be the case and indicate that a certain amount of ripeness or acid due to fermentation in milk is desirable for Swiss cheese making.

At the Ohio State Fair culture cheese won the first seven and the ninth to twelfth places. At the Dairy Industries Exposition culture cheese won the first and fourth places, and at the Ohio Swiss-cheese convention the first nine places.

Milk production was large during the year and considerable surplus market milk was made into Swiss cheese.

A system of reporting the make and grades of cheese sold has been worked out, and reports are being made weekly. The plan for the coming year is to continue this work, and in addition as much time

as possible will be spent in an attempt to improve the quality of the milk.

NEW YORK

Five Swiss-cheese factories in New York cooperated with the bureau in carrying out the culture method. Two of the factories, however, closed because of market-milk competition. The quantity of cheese made by the culture method was approximately 300,000 pounds, as compared with 386,000 pounds the previous year. The greatest defect in the cheese was checking.

WISCONSIN

At the request of leaders in the Swiss-cheese industry of Wisconsin the bureau placed a specialist in their State to aid in improving the quality of their product and to introduce the culture method of manufacture in factories. This work is being done in cooperation with the University of Wisconsin, which has provided a man to help the patrons of Swiss-cheese factories to improve the quality of their milk. After a preliminary survey arrangements were made with three factories to use the cultures and the culture method of making Swiss cheese.

CONCENTRATED SOUR SKIM MILK

No effort has been made to extend the manufacture of concentrated sour skim milk as the demand for it is no greater than the supply. The process was introduced in one plant in Mississippi, cultures were furnished to several plants, and a number of inquiries were answered relative to this product.

CASEIN

The introduction of the bureau's grain-curd method of making casein, which was begun in the spring of 1930, was continued through the fiscal year 1931. Eight plants in the East were interested in the grain-curd method, and the method was demonstrated in their plants. Five of the plants adopted the method and have used it continuously through the year. These plants are well pleased with the results obtained.

Another specialist conducted casein-introduction work in 13 States, especially in Wisconsin, Idaho, and California. In 48 of the plants visited where casein was being made, 40 were using the lactic-acid or natural-sour process, 6 the sulphuric-acid, and 2 the hydrochloric-acid process. One of those using hydrochloric acid adopted the grain-curd method, and it is probable that other plants may adopt the method.

As the survey showed that lactic-acid casein was manufactured to a greater extent in the Western States than any other type of casein, the introduction of improved methods of making lactic-acid casein was included in the field work. Considerable experimental work was done by the bureau, and a new method of making lactic-acid casein was developed. This grain-curd lactic-acid casein has many of the desirable properties of the grain-curd hydrochloric-acid

casein and can be made without the expense of buying acid for precipitating the curd.

The dairy departments of a number of the State colleges cooperated effectively with the bureau specialist and arranged demonstrations and meetings with interested plant managers.

The project to improve the quality of domestic casein has aroused a great deal of interest and is considered to be in line with the needs of the industry. The general plan of the work will be continued and an attempt made to further improve and simplify the manufacturing methods.

THE GROVE CITY CREAMERY

At Grove City, Pa., is a cooperative creamery in which the bureau, by cooperative arrangement, maintains a research laboratory and tries out the results of its research work under commercial factory conditions. A method for making an improved type of cottage cheese, described elsewhere in this report, was tested out on a large scale during the year with good results.

INSPECTION OF RENOVATED-BUTTER FACTORIES

The sanitary inspection of all renovated-butter factories licensed by the Bureau of Internal Revenue is the only strictly regulatory work done by this bureau. The amount of renovated butter made in the United States is gradually declining, largely because the output of farm butter from which nearly all renovated butter is made has decreased. In 1921 there were 11 licensed factories, and now there are only 4.

COTTAGE CHEESE

One of the most profitable outlets for skim milk is in the form of cottage cheese. In general, the manufacturing methods used in making cottage cheese and the quality of the cottage cheese produced lack uniformity. Assistance has been given to a number of companies in improving the quality of their cottage cheese.

Cottage cheese is a valuable food product, and when it is properly made it is highly esteemed by the consuming public. The character and the quality of the finished product depend very largely upon the methods used in manufacture. The low-acid rennet type of cottage cheese has been made by a number of creameries, dairies, and milk-product plants, but with varying degrees of success. The low-acid rennet type is a superior and profitable product when properly made. In order to determine the best method for making a uniformly high-grade cottage cheese of this type, the bureau, by experimental work conducted in the laboratory and on a commercial scale, demonstrated a method which has consistently produced excellent results. This method is now in operation in the commercial creamery at Grove City, Pa. By using this method more dairy-products plants could improve the quality of their cottage cheese and more profitably utilize their skim milk.

OTHER ACTIVITIES

In addition to the activities on these main projects, this division cooperated with the research laboratories in experiments in canning Cheddar cheese, superintended students' national contests in judging dairy products, superintended commercial butter and cheese exhibits and contests at two national expositions and State fairs, and bureau specialists served as instructors in short courses in dairy manufacturing at several of the State colleges of agriculture.

EDITORIAL AND INFORMATION WORK

During the year six publications were printed for distribution, two of which were new and four were revisions of existing publications. Nine additional manuscripts were submitted for publication, and at the end of the year 16 manuscripts covering new publications and revisions of existing ones were being edited prior to submission for printing. These publications and manuscripts are representative of the various activities of the bureau and are both scientific and popular in character. Twenty-one existing publications were also reprinted one or more times during the year, and bureau specialists contributed 14 articles to *The Yearbook of Agriculture* for 1931. The staff of the bureau contributed a total of 53 articles to the scientific, dairy, and agricultural journals, and delivered many radio addresses.

Twenty-two releases of bureau information dealing with various phases of the bureau's work were prepared and issued to the press through the department's press service, and this material was widely used by the press.

The value of furnishing information to the dairy industry through the press is indicated in connection with the press release on the low-acid rennet method of making cottage cheese, referred to elsewhere in this report. A mimeographed circular describing the method was prepared for distribution in March, and a press release was issued regarding the circular. Within a few weeks 2,175 requests for a total of 2,200 copies of the circular were received. These requests came from all over the country.

The bureau cooperated with the radio service in scheduling and preparing a total of 104 radio broadcasts of dairy information. Of these 47 were broadcast over the national chain of stations associated with the National Broadcasting Co., 52 were syndicated to individual stations, and 5 were broadcast from various stations upon special request.

The bureau assisted the office of exhibits in preparing subject-matter for dairy exhibits at the National Dairy Exposition, St. Louis, Mo., and at 13 State and interstate fairs. Dairy exhibits were shown at 36 State or interstate fairs.

Assistance was given the office of motion pictures in the preparation of new educational films and in the revision of existing ones.

Two new lantern-slide lectures—one on the production of high-quality milk and the other on the breeds of dairy cattle—were made in cooperation with the office of cooperative extension work.

PUBLICATIONS

The following manuscripts written by members of the bureau's staff for the purpose of disseminating information on the bureau's work to the public, were published during the year, as department publications or as articles in scientific journals or in the agricultural, dairy, or general press:

FEEDING AND NUTRITION

- Calcium and phosphorus metabolism in dairy cows. IV. The assimilation of calcium fed as calcium gluconate. *Jour. Dairy Sci.* 14: 268-275.
 Calculating rations for dairy cows. *Jour. Dairy Sci.* 14: 173-176.
 Cattle often killed by nails, wire, etc., eaten with the feed. U. S. Dept. Agr. Yearbook 1931: 128-130.
 The comparative effectiveness, in a cow's ration, of supplements of phosphorus in the form of orthophosphoric acid, mono-, di-, and trisodium phosphate. *Jour. Biol. Chem.* 92: xiv.
 New rule for feeding grain. *Hoard's Dairyman* 75: 985.
 The vitamin A content of different grades of alfalfa and timothy hays and of hays cured under various conditions. *Jour. Biol. Chem.* 92: vii-viii.

BREEDS AND BREEDING

- Breeding of dairy cattle. Doc. Material on the Inter-Amer. Conf. on Agr., Forest., and Anim. Indus. 1930: 133-137.
 Can we breed pure strain cows for greater milk and higher butterfat production? *Certified Milk* 6 (62): 5, 9.

HERD MANAGEMENT AND IMPROVEMENT

- Can we spare 2,250,000 cows? Our dairy herds contain that many animals which are kept at a tremendous loss. *Farm Jour.* 54 (10): 22, 32.
 Dairy-bull associations increasing and building up herds' production. U. S. Dept. Agr. Yearbook 1931: 183-184.
 Dairy bulls proved by herd associations often fall below requirements. U. S. Dept. Agr. Yearbook 1931: 184-185.
 Dairy-cow culling often profitable in herds of high-average production. U. S. Dept. Agr. Yearbook 1931: 186-187.
 Dairy records indicate needed margin between costs and production. U. S. Dept. Agr. Yearbook 1931: 188-190.
 Experiment stations operated on management of dairy herds. Federal agency has 23 technically trained specialists to carry on work. U. S. Daily 5 (262): 6; (263): 6.
 It's the big cows that count. *Dairy Tribune* 1 (5): 3, 19.
 More than half million cows on test for milk production. Information is collected and tabulated for benefit of dairy owners by Government bureau. U. S. Daily 5 (263): 6.
 One good cow is worth seven poor ones. *Dairy Tribune* 2 (6): 6.
 Stick to the cow says this dairy economist. *Dairy Tribune* 1 (8): 8.
 When is a dairy cow profitable? *Hoard's Dairyman* 75: 761.

MILK

CARE AND HANDLING

- Dairy earnings larger if cream is marketed while fresh and sweet. U. S. Dept. Agr. Yearbook 1931: 187-188.

- Improving the quality of dairy products. *Ice Cream Trade Jour.* 26 (8): 54.
 Investigations are conducted for improving supply of milk. Government agency assists local authorities to formulate laws to safeguard public. U. S. Daily 5 (265): 6.
 Market milk—its production, processing, and distribution in the United States. Doc. Material on the Inter-Amer. Conf. on Agr., Forest., and Anim. Indus. 1930: 139-143.
 Milk-bottle losses partly traceable to consumers' negligence. U. S. Dept. Agr. Yearbook 1931: 379-380.
 Milk improvement on nation-wide basis is dairy extension aim. U. S. Dept. Agr. Yearbook 1931: 381-383.
 Milk quality improvement in the extension program. U. S. Dept. Agr., Ext. Serv. Circ. 146. [Mimeographed.]

COOLING

- The ice well for the dairy farm. U. S. Dept. Agr. Circ. 155.
 Ice-well refrigeration for dairy farms—works well at Mandan, N. Dak. U. S. Dept. Agr. Yearbook 1931: 307-310.

FLAVOR AND ODOR

- Abnormal flavors in milk. 23d Ann. Conv. Internatl. Assoc. Milk Dealers, Lab. Sect. Proc. 1930: 20-25.

CHEMISTRY

- Buffer capacities of various milks and proprietary infant foods. *Amer. Jour. Diseases Children* 40: 260-268.
 The determination of the calcium, magnesium, and acid-soluble phosphorus of milk by means of trichloroacetic acid filtrates. *Jour. Biol. Chem.* 90: 747-756.
 The effect of preheating on the dispersity of calcium caseinate in skim milk. *Jour. Phys. Chem.* 35: 1303-1307.
 A test for the detection of milk unstable to heat. *Jour. Dairy Sci.* 14: 93-106.
 Variations in the buffer value of herd milk. *Jour. Dairy Sci.* 4: 50-58.

BACTERIOLOGY

- Bacterial growth in the udders of living cows compared with that in the udders following death and removal of the blood supply. *Jour. Infect. Diseases* 48: 408-412.
 Continuous fermentation in the production of lactic acid. *Indus. and Engin. Chem.* 23: 532-534.
 The germicidal action of raw milk upon an organism of the sweet curdling type. *Jour. Dairy Sci.* 14: 276-282.
 The growth of bacteria in a continuous flow of broth. *Jour. Bact.* 20: 127-137.
 Influence of osmotic pressure upon spore germination. *Jour. Bact.* 21: 197-209.
 Influence of surface tension upon the germination of bacterial spores. *Jour. Bact.* 21: 211-218.
 The origin of the growth-restraining substance in raw milk and the action of this substance upon an organism of the sweet curdling type. *Jour. Bact.* 21: 38-39.

Significance of thermophilic bacteria in pasteurized milk. Amer. Jour. Pub. Health 20: 815-819.

Studies on the influence of bacteria on the oxidation-reduction potential of milk. I. Influence of pure cultures of milk organisms. II. Influence of associated cultures of milk organisms. Jour. Bact. 21: 239-262.

Studies on the proteolytic bacteria in milk. V. Action of proteolytic bacteria on milk serum. Jour. Bact. 21: 263-271.

SECRETION

Milk secretion shown by experiments to be a continuous process. U. S. Dept. Agr. Yearbook 1931: 384-388.

BUTTER

Creamery industry in South is solving its development problems. U. S. Dept. Agr. Yearbook 1931: 176-180.

Federal investigations aiding milk product manufacturers. Service is designed to assist factories producing butter, cheese, and condensed and dry milk. U. S. Daily 5 (261): 6.

CHEESE

Cheese making in some sections necessitates pasteurization of milk. U. S. Dept. Agr. Yearbook 1931: 140-142.

The manufacture of low-acid rennet-type cottage cheese. U. S. Dept. Agr. BDIM 543. [Mimeographed.]

Methods for determining the persistence of certain important bacteria in Swiss cheese. Jour. Bact. 21: 40-41.

Studies on the eye-forming organism of Swiss cheese. Jour. Bact. 21: 39-40.

ICE CREAM

Ice cream in the research laboratory. Ice Cream Rev. 13 (12): 56, 58, 88.

The ice cream industry. Hoard's Dairyman 75: 753.

A new form of lactose crystal found in sandy ice cream. Jour. Dairy Sci. 13: 471-477.

BY-PRODUCTS

CASEIN

Bromoresol green paper in the manufacture of grain-curd casein. Jour. Dairy Sci. 14: 26.

Casein, its possibilities as a product of the dairy industry. Amer. Creamery and Poultry Prod. Rev. 71: 196-197, 213.

Casein of high quality increases profits of the dairy industry. U. S. Dept. Agr. Yearbook 1931: 126-128.

The iso-electric point in producing casein. Paper Trade Jour. 92 (13): 55-56.

WHEY

The continuous lactic fermentation of whey. Jour. Bact. 21: 37.

Normal and modified foaming properties of whey-protein and egg-albumin solutions. Indus. and Engin. Chem. 22: 1124-1128.

LACTOSE

Speed of crystallization of lactose, galactose, glucose, and sucrose from pure solution. Indus. and Engin. Chem. 23: 670-673.

MILK PLANTS

Milk plants of small size must be carefully planned and operated. U. S. Dept. Agr. Yearbook 1931: 383-384.

Some economic factors in milk-plant layout. Milk Plant Mo. 22 (2): 40, 42, 44, 48.

MISCELLANEOUS

The action of alkali on thiohydantoin derivatives of cystine and cysteine. Jour. Biol. Chem. 88: 403-407.

Dairying. Amer. Yearbook 1930: 390-393.

Developing dairy extension. U. S. Dept. Agr., Ext. Serv. Rev. 2: 17-18.

Effect of moisture content of flour on heat of imbibition developed during the mixing of bread dough. Cereal Chem. 8: 162-165.

Effective methods of controlling the fly nuisance on dairy farms. Dairymen's League News 14 (27): 2, 12.

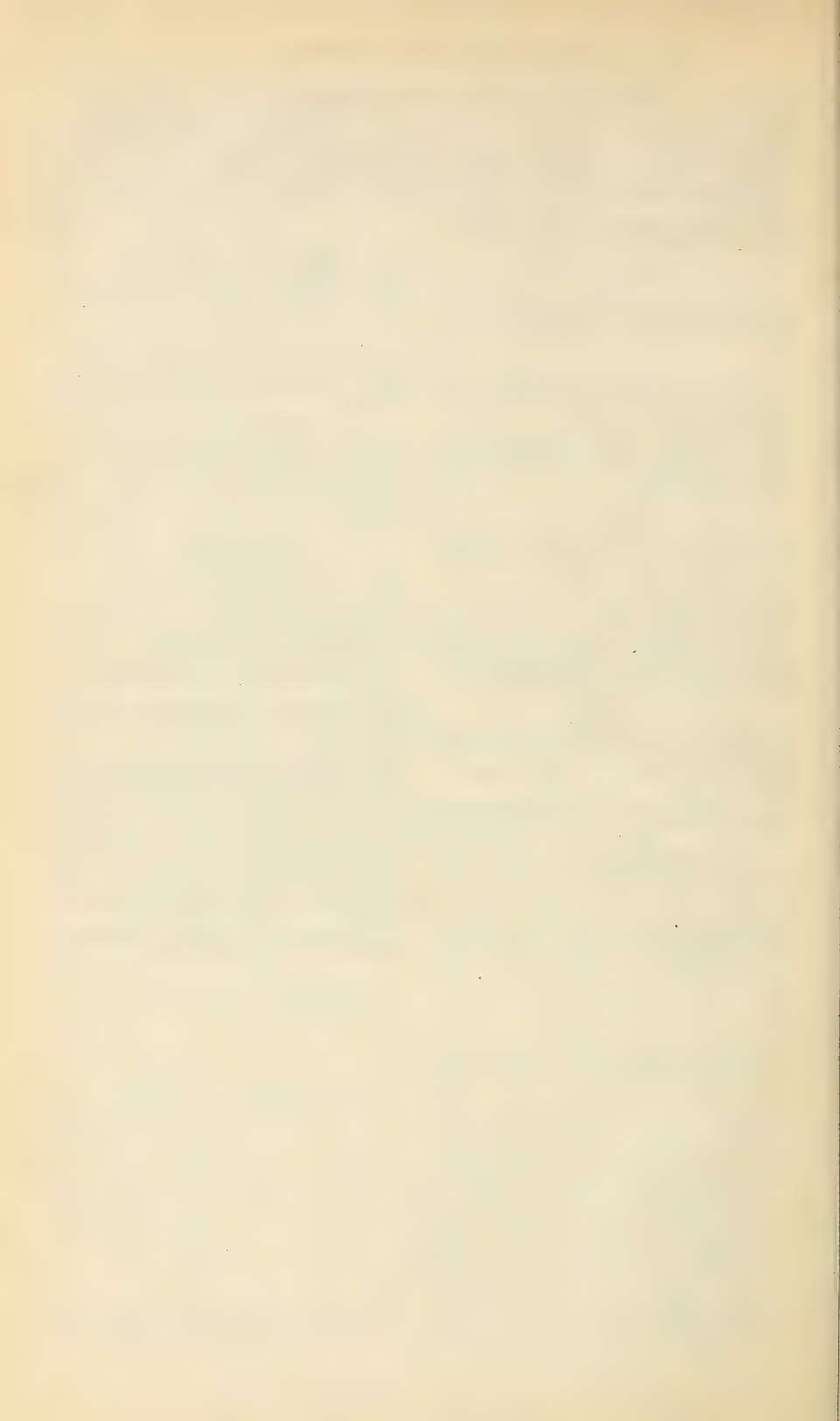
Laboratory studies conducted for the benefit of dairy industry. Researches by Government agency also frequently aid other industries which use by-products. U. S. Daily 5 (266): 6.

Report of the chief of the Bureau of Dairy Industry for the fiscal year ended June 30, 1930.

The structure of glutathione. Jour. Biol. Chem. 88: 389-393.

Thiohydantoin derivatives from cystine and from cysteine. Jour. Biol. Chem. 88: 395-401.

A three-billion-dollar industry. Holstein-Friesian World 27: 1891, 1912.



REPORT OF THE CHIEF OF THE BUREAU OF ENTOMOLOGY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., September 30, 1931.

SIR: I submit herewith a report of the work of the Bureau of Entomology for the fiscal year ended June 30, 1931.

Respectfully,

C. L. MARLATT,
Entomologist and Chief of Bureau.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The fiscal year has been characterized by important changes in the bureau's personnel and also by certain minor regroupings of activities, involving changes in the functional organization, some of which became effective within the year. It is expected that all these adjustments will be completed before the beginning of the season of active field operations for 1932.

CHANGES IN PERSONNEL

The retirement, October 15, 1927, of L. O. Howard from the position of Chief of the Bureau of Entomology was recorded in the annual report of that fiscal year. Doctor Howard was, however, retained in the bureau for four years beyond the retirement age, under provision of the retirement act, and during this period he prepared two books which in a sense summarize or are based on the work in economic entomology as developed in this and other countries. These are *A History of Applied Entomology* (1930), published by the Smithsonian Institution, and *The Insect Menace*, shortly to be issued by a commercial publisher. Doctor Howard's retirement from the bureau on June 30, 1931, closes his official connection with the department covering a period of some 53 years (1878-1931). A more extended statement of Doctor Howard's work was given in the Official Record of the department for July 4, 1931.

Mr. C. N. Ainslie, after 24 years of service in the bureau in work on insects affecting cereal and forage crops in the Middle West, having reached the maximum age limit, was retired October 31, 1930. His assignments have been important and his work, of great usefulness, has record in many reports and some 24 publications.

Early in the fiscal year L. B. Smith, principal entomologist, in charge of the Japanese beetle laboratory at Moorestown, N. J.,

resigned. Pending the reorganization of Japanese and Asiatic beetle investigations, W. R. Walton, of the Division of Cereal and Forage Insects, was placed in acting charge of the laboratory and field work. As part of the plan of reorganization of the bureau, already discussed, the Japanese and Asiatic beetle investigations were set up as a field division responsible directly to the chief of bureau. On December 16, 1930, C. H. Hadley was appointed to take charge of this work. Mr. Hadley came to the bureau by transfer from the Plant Quarantine and Control Administration, where he had been in charge of the Japanese beetle quarantine work since 1928. At an earlier period (1919-1923) he had been in charge of Japanese beetle work both as to research and quarantine enforcement.

Other important changes have been made in the bureau's personnel during the year. A. L. Quaintance, associate chief of bureau and chief of the Division of Deciduous Fruit Insects, resigned December 31, 1930. During his long connection with the bureau (1903-1930) he rendered a very notable service, the permanent record of which is the development of important work in his subject carried out by enthusiastic and competent personnel at stations established at strategic points in the United States, and the numerous bulletins, circulars, and other publications which have been issued under his own name, together with many others which have reported the work supervised by him at field stations.

So far the position of chief of the Division of Deciduous Fruit Insects has not been filled, but the work has been carried in the interim by the chief of bureau, assisted by B. A. Porter.

The position of chief of the Division of Cotton Insects, for many years held by B. R. Coad, was taken over February 10, 1931, by F. C. Bishopp, in an acting capacity, in addition to his responsibility as chief of the Division of Insects Affecting Man and Animals. Mr. Bishopp had been associated with the late W. D. Hunter, who for many years was in charge of cotton-insect work, and was familiar with the industry and its problems. On June 20, 1931, R. W. Harned, head of the State Plant Board of Mississippi, was appointed chief of the Cotton Insect Division. Mr. Harned is recognized as one of the outstanding entomologists in the country, has held many important offices in national scientific organizations, entomological and other, and is thoroughly familiar with the problems relating to insects injurious to cotton. It is believed that under his leadership research work in this field will be developed with increased vigor and effectiveness.

The position of Associate Chief of the Bureau of Entomology, made vacant by the resignation of Doctor Quaintance, has not been filled under that title, but what is substantially the equivalent of that position in duties and responsibility has been classified and established under the title of assistant chief of bureau. J. E. Graf was appointed to this new position February 21, and resigned March 4, 1931, to accept the newly created position of associate director of the United States National Museum. The loss of Mr. Graf was a serious one to the bureau, inasmuch as it vacated not only the position of assistant chief but also the position of chief of the important Division of Truck Crop Insects. This latter vacancy has not yet been filled, but in the interim the administration of this division is being carried by W. H. White as acting chief.

The position of assistant chief of bureau relinquished by Mr. Graf was filled by the appointment, April 1, 1931, of S. A. Rohwer, by transfer from a similar position in the Plant Quarantine and Control Administration of the Department of Agriculture. Mr. Rohwer entered the service of the Bureau of Entomology in 1909 in the Division of Forest Insects. He was later put in charge of the taxonomic work of the bureau in Hymenoptera, and afterwards took charge of the numerous bureau personnel engaged in taxonomic work. In 1927, in recognition of his administrative ability, he was appointed business manager of the bureau and in this position assisted the present chief of bureau in the reorganization of 1927-28 which resulted in assembling all the plant quarantine, regulatory, and general control work under the new unit entitled Plant Quarantine and Control Administration, of which unit he became assistant chief July 1, 1928. Mr. Rohwer is a technical entomologist, and his long experience in the bureau in research and in administrative work has well fitted him for the position which he now holds. The duties of assistant chief of bureau as now classified are to assist the chief of bureau in the direction of all investigational and research work.

To replace the old position of assistant chief in charge of business management a new position has been set up—that of chief of the section of administration—to take charge, under the direction of the chief of bureau, of all business and personnel matters. This position was filled on March 6 by the appointment of Frank H. Spencer, who for the last six years has been administrative assistant to the Secretary of Agriculture, and prior to that time had held other administrative positions in the department.

A. C. Baker will be transferred to Mexico City, where he will direct the laboratory established there by the bureau in 1928 for investigating, in cooperation with the Department of Agriculture of Mexico, fruit flies and other tropical insect pests. Doctor Baker has on various occasions expressed a wish to devote the major part of his time to research, which his duties in administering widely scattered sections made impossible, and in the field of research has expressed a preference for the very important station which he had established in Mexico City. Inasmuch as the Mexico City station has recently lost several of its important research personnel, the time was particularly favorable to give Doctor Baker this opportunity. It is expected, however, that he will remain in close contact with all the work of the bureau dealing with tropical fruit flies and other tropical insects, and that he will cooperate in planning the research on these problems carried on at the bureau laboratories in the Canal Zone and in Hawaii.

CHANGES IN DIVISIONAL CLASSIFICATION OF WORK

The changes in administrative structure of the bureau, referred to above, indicated this as a favorable time for minor reorganization of the subject matter of the bureau in its divisional classification. This reorganization became effective in part during the fiscal year 1931, and it is expected that the adjustments will be fully completed before the active season of 1932 begins. The reorganization will be reflected in the classification of work and in the appropriation

language for the fiscal year 1933. Its purpose is to bring together related activities or activities which involve related control methods. The principal change involved is the elimination of the Division of Tropical, Subtropical, and Ornamental Plant Insects and the distribution of its component elements to other existing divisions. The changes in the distribution of subject matter of the bureau resulting from the reorganization are as follows: (1) The Division of Deciduous Fruit Insects becomes the Division of Insects Affecting Fruit and Shade Trees and includes citrus and other subtropical fruits in addition to deciduous fruits, while, by transfer from the Division of Forest Insects, it assumes all work involving shade and ornamental trees and shrubs, which, both as to insect enemies and control measures, is closely related to orchard operations. (2) The Division of Truck Crop Insects becomes the Division of Insects Affecting Truck and Garden Crops, to include, in addition to truck crops, insects affecting greenhouse plants, bulbs, roses, and other florist stock. (3) The Division of Insects Affecting Stored Products, including household pests, is enlarged by transfer from the Division of Forest Insects of the section dealing with termites and certain other insects attacking wood in buildings, furniture, and stored finished-wood products. To this division also will be added the new appropriation available July 1 for the study of control of the Argentine ant, whose major importance is as a household pest. (4) The appropriation item Taxonomy and Interrelations of Insects includes important basic subjects necessary for the conduct of much of the bureau's economic work but heretofore carried on in other divisions without specific leadership. The subjects grouped together are not necessarily closely related and the assemblage under one item is purely for administrative purposes. These subjects are as follows: (1) Taxonomic investigations, (2) insect pest survey, (3) public relations, (4) bioclimatics, (5) morphological investigations, (6) exchange of useful insects, (7) physiology and toxicology, (8) disinfection, and (9) insect diseases.

BUDGET INCREASES

The Budget for the fiscal year 1931 includes increases totaling \$329,440 for old and continuing subjects and for undertaking new lines of work. No reductions were made in funds for activities already under way.

NEW SUBJECTS

The more important increases for new work may be summarized as follows: For large-scale tests to determine value of bait traps against the oriental fruit moth, \$50,000; for investigating the life history, habits, and means of controlling the cyclamen mite, \$5,000; for experiments relating to the control of resistant scale insects affecting citrus fruits, \$25,000; for investigations of the pea weevil, \$5,000; for development of methods for the control of wireworms in the Pacific Northwest, \$25,000; for developing methods of control of wireworms in South Carolina, \$7,500; for devising control methods for the Lima-bean pod borer, \$7,500; for investigating the control of the range caterpillar, \$10,000; for determining means of controlling mosquitoes in Oregon, \$10,000; for investigation of ticks

and tick parasites, \$5,000; for initiating investigations of sand flies, \$16,100; for study of reindeer insects in Alaska, \$6,000; for investigations of the tobacco or cigarette beetle, \$10,000; for investigations of insect pests injurious to confections and nut meats, \$5,000; for the identification of plant bugs, \$4,000; for initiating work of a special unit which will expedite the distribution of information on pest control to farmers, fruit growers, and livestock producers, \$14,740; for studies on the preparation of honey for market, \$5,600; and for apiary investigations in the Pacific Coast States, \$15,000.

OLDER OR CONTINUING SUBJECTS

For expanding the apple-insect work at Yakima, Wash., and other places in the Pacific Northwest, \$5,000; for enlarging pecan-insect work, \$8,000; for collecting, rearing, and shipping to the United States, parasites of the Japanese and Asiatic beetles from Australia and Europe, \$20,000; for enlarging the investigations on the oriental fruit moth and plum curculio in southern peach orchards, \$8,420; for furthering the investigation of control measures for the strawberry root aphid, \$3,940; for investigating the control of tree-killing bark beetles in the Western States, \$10,210; for investigating the control of insects injuring shade and park trees, \$5,790; for investigating the habits and control of the alfalfa weevil in southern Oregon, \$4,380; for enlarging the investigations of leaf hoppers and other insects involved in diseaselike injury to alfalfa, clover, and similar forage legumes, \$10,000; for expediting the importation and colonization of sugarcane-borer parasites, \$10,000; for enlarging investigations on clothes moths, \$10,000; for identifying mosquitoes and other blood-sucking flies, \$6,000; for employing clerical assistance necessitated by the growth of the insect pest survey, \$1,260.

DECIDUOUS FRUIT INSECTS

PEACH INSECTS

The major peach insects under investigation have been the oriental fruit moth and the plum curculio. A new laboratory was established in the spring of 1930 at Harriman, Tenn., for the purpose of investigating both of these insects, which in recent years have caused serious losses to Tennessee peach growers. Other peach insects of lesser importance will also be investigated under conditions which exist in eastern Tennessee.

ORIENTAL FRUIT MOTH

The oriental fruit moth continues to provide one of the most difficult fruit-insect problems under investigation. Thus far the entomologists working on this pest have been unable to recommend practical means of control to the growers.

Certain phases of the biology of the oriental fruit moth are being investigated further. Particular attention is being given to the dissemination habits of the moths. Numerous releases of marked moths reared from material collected in the orchards are being made in the large areas in which bait traps are maintained, as well as in other areas. Screens covered with sticky material have also been erected

at several points for capturing marked moths. This work is only well under way, but the results thus far indicate that many of the moths move rather freely from point to point and do not remain close to the place where they emerged. The information resulting from these studies will have an important bearing on the application of any control measures which may be developed. It will also be a valuable aid in laying out experimental plats and in interpreting the results of control experiments.

Previous efforts to control the fruit moth by means of insecticides have given very discouraging results. Insecticide studies are being continued, however, at the Vincennes, Ind., and the Takoma Park, Md., stations. Most of this work is conducted in the laboratory, and at present there is little of a positive nature to report.

Special emphasis has again been placed on the biological control of the oriental fruit moth, because of the absence of adequate insecticidal control measures. In the eastern areas, in which the fruit moth has been present for the longest period of time, the early-season twig-infesting broods of larvæ are very much reduced in numbers by numerous native parasites. The work of introducing these parasites into other areas, from which they have been found to be absent, has been continued on an increasing scale. It is hoped that the parasites thus introduced will cause a progressive decrease in the oriental fruit-moth population, and a corresponding decrease in the economic losses it causes.

Adults of *Macrocentrus ancylivora* Rohwer, one of the most important native fruit-moth parasites in the Eastern States, have been shipped successfully from there to southern Illinois, a distance of more than 800 miles. By packing the containers used for shipping adults of this species in ice-cream tubs, packed with sawdust and ice, the insects can be maintained at temperatures of 45° to 50° F. for two or three days. Under these conditions they reach all destinations in the eastern half of the United States with a negligible mortality. From material reared at the Moorestown, N. J., laboratory 86 colonies comprising nearly 25,000 adults of *Macrocentrus ancylivora* were shipped during 1930, and colonized in various peach-growing sections in 13 States, chiefly east of the Mississippi River. Similar liberations are being made this season. Recovery collections made thus far have indicated that a high percentage of the liberations have been successful.

The parasite work is being carried on in close cooperation with various State organizations, which have in many cases furnished funds and labor for collecting material with the purpose of benefiting the peach industry within their borders. Large numbers of oriental fruit moth and strawberry leaf-roller larvæ parasitized by *Macrocentrus* have been collected under the supervision of bureau representatives and shipped to the interested State organizations.

Six colonies of adults of another parasite, *Glypta rufiscutellaris* Cress., including some 1,526 parasites, have been liberated in peach orchards in Georgia and the Carolinas. Four experimental liberations of 1,752 adults of *Pristomerus ocellatus* Cush., a fruit-moth parasite found in New Jersey, have also been made at points in northern Georgia, eastern Tennessee, and southern Indiana.

Mass rearing of *Trichogramma minutum* Riley is also being conducted in an effort to ascertain the value of liberations of these parasites in peach orchards. It has been found that during the winter, spring, and early summer the eggs of the native bagworm, kept in cold storage, provide an economical medium for mass rearing of *Trichogramma*.

In order to provide a sound basis for a more intelligent distribution of these parasites, a more comprehensive parasite survey than any hitherto undertaken is being conducted, in combination with recovery collections at points where liberations have previously been made.

The Bureau of Entomology has for the last two years maintained an investigator in southern France and northern Italy, in the hope of obtaining additional valuable parasites of the fruit moth. Shipments have already been made of four species of European parasites, including *Pristomerus vulnerator* Panz., *Apanteles anarsiae* F. and A., *Zenillia roseanae* B. and B., and *Ascogaster quadridentatus* Wesm. The last-named species is considered by some authors to be identical with *A. carpocapsae* Vier., which attacks both the oriental fruit moth and the codling moth in the United States. The form *quadridentatus*, however, appears to attack the oriental fruit moth more freely in Europe than does *carpocapsae* in the United States. *A. quadridentatus* has been successfully carried over the winter in the United States. *P. vulnerator* was liberated in cages and in the open at Moorestown, N. J., in the spring of 1931, under very favorable conditions, although there appears to be some doubt whether the species has established itself.

As a by-product of the European parasite work, shipments have been made of *Copidosoma pyralidis* Ashm., an important European parasite of the peach twig borer, *Anarsia lineatella* Zell. These were received at New York and immediately forwarded by air mail to State officials in California, where the peach twig borer is an important pest. One of these colonies was shipped from southern France to California in only 12 days, and reached its destination in perfect condition. Shipments of *Macrocentrus ancylivora* have also been made from the United States to France in order to aid in the natural control of the fruit moth in that country.

In last year's report mention was made of the large-scale bait-trap work authorized by Congress in the first deficiency act of 1930. This appropriation provided for two large-scale experimental tests of the use of traps, filled with various attractive substances, for the control of the oriental fruit moth. When used by individual growers, the bait traps have caught large numbers of moths, but have failed to show material benefit to the individual orchard concerned. Possibly this has been because many additional moths were attracted to the orchard from unbaited orchards. The large-scale experiments were for the purpose of determining the value of the baits when used over an extensive acreage.

Those conducted during the season of 1930 were inconclusive, because of the absence of a peach crop in Indiana and the unexpected lightness of the infestation at both Vincennes, Ind., and Cornelia, Ga., the localities in which the work was conducted. In the latter district the moth population within the baited area, as

indicated by fruit-infestation records and by counts of injured twigs, was only one-half of that in the surrounding unbaited area. At Vincennes, however, the infestation in the baited area, as indicated by counts of injured twigs, was slightly greater than that outside the area.

On account of the abnormal conditions under which the large-scale tests were carried on in 1930, provision was made by Congress for their continuation for another season. It is of course too early to predict the outcome of this year's tests, although at Cornelia, Ga., the infestation in the unbaited area appears at the present writing (July, 1931) to be increasing much more rapidly than that in the baited area.

During the early season of 1931 the infestation was extremely light in both Georgia and Indiana. The moth population may build up to significant numbers by the end of the season, however, since the heavy peach crop which is present in both regions in which this work is under way provides an abundant food supply.

The project this season has been modified to provide a greater number of comparative tests of different bait materials. These experiments include comparisons of various grades of sugar and molasses, numerous aromatic chemicals; and various strengths of these materials. The results obtained thus far indicate rather definitely that the medium to lower grades of brown sugar and the higher grades of molasses make the most attractive baits.

In order to obtain information on the proportion of the moth population which is caught, the movements of the moths, and the distances which they normally travel, as well as the distances to which they are attracted by the traps, small numbers of marked moths reared from larvæ collected within the area have been liberated. The percentage of recovery has ranged from 28 per cent during cold, unfavorable weather, when the moths are comparatively inactive, to 80 per cent under more favorable conditions. In one case 20 out of 50 marked moths were recovered the night following their release, the bait solutions in this case being three weeks old. Several moths liberated a quarter of a mile from any traps were recaptured in the traps. One moth traveled more than a mile in six days. These experiments and observations are furnishing valuable information on the dissemination habits of the moths and on their behavior in areas in which traps are maintained.

PLUM CURCULIO

Mention was made in the last annual report of the extremely severe infestation of the plum curculio in southern peach orchards in the summer of 1929. A remarkable reduction in the infestation has since occurred, largely because of three major factors: (1) The emergence of adults from hibernation in the spring of 1930 was later than usual, which reduced the second brood to much less than normal numbers. (2) The early summer of 1930 was extremely hot and dry, a condition very unfavorable to the insect when in the pupal stage in the ground. This caused a further reduction in the general curculio population. (3) The control measures recommended by the Bureau of Entomology were carried out with an unusual degree

of thoroughness. For the most part these conditions have been duplicated in the early season of 1931, and as a result the curculio infestation is now at an extremely low ebb.

Earlier tests having shown that potassium fluosilicate offers promise as a substitute for lead arsenate in the control of the plum curculio on peach, this season's tests at both Fort Valley, Ga., and Harriman, Tenn., included large plats sprayed with this material. Thus far no foliage injury of consequence has developed. The results in curculio control have not yet been recorded. Barium fluosilicate and cryolite, which have shown some promise as substitutes for lead arsenate, and which were reported on favorably by the Tennessee Agricultural Experiment Station last year, are also being tested on a field scale at the Harriman, Tenn., laboratory.

Possible supplementary means of controlling the curculio are also under investigation, particularly at the Fort Valley laboratory. The burial of curculio-infested peach drops, which is sometimes suggested, has been found unreliable, since adult curculios have emerged this season from drops which were buried to a depth of 3 feet, and adults have emerged in considerable numbers from a depth of 1½ to 2 feet. Submerging infested drops in water for short periods of time has been found to have very little effect upon the curculio larvæ, although after a period of 28 days practically all of them were killed. It has been found that the exposure of peach drops on the ground to the direct rays of the sun is fatal to all larvæ within them.

A number of soil treatments for the control of larvæ and pupæ are being given preliminary tests. The most promising of these treatments is spraying the soil with a 4 per cent emulsion of mineral oil in which paradichlorobenzene has been dissolved. This has been found 100 per cent effective against the pupæ in the soil.

A new lightweight curculio-jarring sheet was devised by the staff of the Fort Valley laboratory during the year, and a brief article describing this has been published.

OTHER PEACH INSECTS

Some attention has been devoted to various other peach insects, particularly to the peach borer (*Synanthedon exitiosa* Say) and the lesser peach tree borer (*S. pictipes* G. and R.). Paradichlorobenzene dissolved in cottonseed oil (2 pounds of the chemical in 1 gallon of oil) has continued to give very satisfactory results in the control of the lesser peach borer. While recommended for use chiefly on those parts of the trees injured by the borers, this solution has also been applied to the trunk and branches of young uninfested trees without any apparent injury. It has also been found effective against the shot-hole borer on peach trees.

Emulsions of cottonseed oil in which paradichlorobenzene has been dissolved have given perfect control of larvæ of the peach borer in 1, 2, and 3 year old trees when applied in such quantities that one-fourth to one-half ounce of paradichlorobenzene was placed on each tree. No sign of injury to these trees has yet resulted from this treatment, whereas the use of paradichlorobenzene crystals, as recommended for older trees, has frequently caused injury to trees 1 year,

2 years, and 3 years old under conditions found in Georgia. Because of the danger of injury by the chemical, the use of the worming knife has been recommended for controlling the peach borer on young trees. The use of the paradichlorobenzene solution promises to be much more satisfactory on older trees as well as on young trees, since it considerably reduces the labor cost. Detailed studies of the biology of the peach borer are under way at the stations at Fort Valley, Ga., and Harriman, Tenn.

Experiments dealing with the susceptibility of peach trees to oil sprays have been continued. No injury has occurred in any case from the application of the soap-lubricating-oil emulsion up to a strength of 8 per cent, although some injury has developed in the trees treated with a strength of 10 per cent or more. One tree which had received five annual applications of 12 per cent oil has died. These results mean that the ordinary recommended strength of not more than 3 per cent of oil appears very safe under conditions in Georgia.

APPLE INSECTS

CODLING MOTH

The search for insecticide materials that will give effective control of the codling moth without leaving objectionable residue on the fruit has been continued. The need for such an effective and satisfactory substitute for lead arsenate is becoming progressively greater, because of the continued reduction in the quantity of arsenical residue tolerated on fruit entering interstate commerce, but the problem of finding such a material is proving extremely difficult. At present the situation is met by washing the fruit in either dilute acid or alkali, but the problem can not be considered finally solved until a poison is found that effectively controls the codling moth and yet leaves no objectionable residue.

The most encouraging development in the codling-moth problem has been the continued good results obtained in the Northwest with certain fluorine compounds. Two of these in particular, barium fluosilicate, and cryolite, sometimes referred to as sodium fluoaluminate, gave very satisfactory results in the field tests conducted in 1930, and observations in the early summer of 1931 in the plats sprayed with the same materials indicate that results will probably be equally good in 1931. This year's tests also include a potassium fluoaluminate and potassium fluosilicate, two other fluorine compounds which offer promise in the Northwest. In the more humid sections in the East the fluorine compounds have in previous years proved inadequate for the control of the codling moth, but the encouraging results obtained in the arid western regions suggest that with further study it may be possible to adapt these materials to use under more humid conditions.

No definite tolerance of the fluorine compounds which will be permitted on food products has been announced by the Food and Drug Administration, and in the absence of such information growers in the Northwest are being advised against substituting such materials for lead arsenate in the entire spray schedule. The information which has been obtained about them is, however, being placed before these growers with the suggestion that the fluorine materials may be

worth trying on a small commercial scale in the spray applications against the second brood of worms. Used in this way, neither lead arsenate nor the fluorine compound will be present at harvest time in sufficient quantity to be difficult to remove by means of hydrochloric acid.

The codling-moth work in the Northwest has been cooperative with the Bureau of Chemistry and Soils, as well as with the Bureau of Plant Industry. The former organization has stationed chemists at the Yakima, Wash., laboratory during the past few seasons. In addition to making analyses of sprayed fruit, the chemists have been especially helpful in the investigations of the fluorine compounds. The members of the Bureau of Plant Industry have also cooperated in several phases of the work.

Mixtures of nicotine sulphate with dilute "white oil" emulsions have continued to give fairly good results against second-brood worms in the Northwest, but in other parts of the country the results have been less satisfactory and there appears to be serious doubt whether these combinations will be effective in such sections. Tests of insoluble compounds of nicotine, such as nicotine tannate, have been continued in an effort to discover a form of nicotine that will not wash off in rainy weather, and that will not volatilize too rapidly. The results of these tests thus far have been none too encouraging.

Tests of rotenone have been continued, but results have been disappointing. Because of the high initial toxicity which this material possesses, however, efforts to develop ways of effectively utilizing it are being continued.

Cuprous cyanide, which gave fairly good results in the season of 1929, is being tested further in the season of 1931.

Manganese arsenate was tested on a field scale at several points, in order to obtain further information on the possibility of using it as a substitute for lead arsenate. This would eliminate the objectionable lead portion of the material, even if the arsenical residue were not reduced. The results in codling-moth control have been so poor that manganese arsenate can not be recommended.

The Yakima, Wash., laboratory has cooperated with a number of workers in the Pacific Northwest in a group effort known as the Northwestern cooperative oil-spray project, in testing the various highly refined oils, and combinations of such oils with other materials, against the codling moth. The results of this effort are proving very much worth while, and on them as a basis definite recommendations are drawn up at the close of each season as a guide to commercial growers in working out their spray program.

The field station at Wichita, Kans., will be discontinued at the end of 1931. This laboratory was established in the spring of 1926, in cooperation with the Kansas Agricultural Experiment Station, in order to meet the emergency caused by an extremely severe codling-moth infestation. The work of the Wichita station has shown definitely that under the conditions existing in the Arkansas River Valley the codling moth may profitably be controlled by heavy, thorough, frequent, and timely applications of lead arsenate, although this necessitates washing the fruit to remove the residue. Considerable study at this laboratory has also been given to the distribution of the codling moth in orchards, both from point to

point within an orchard and in the various parts of individual trees. This study is likewise to be completed by the close of this season.

Intensive laboratory testing of large numbers of possible new insecticides for the control of the codling moth has been conducted at the laboratories at Takoma Park, Md., Vincennes, Ind., and Yakima, Wash. During the season of 1930 more than 200 different insecticide materials or combinations were tested at the Vincennes laboratory. At this laboratory a very satisfactory technic for obtaining newly hatched codling-moth larvæ has been developed. During the season of 1930 more than 125,000 larvæ were used in the tests at Vincennes, and in June, 1931, more than 70,000 were used in the insecticide studies. With the exception of certain fluorine compounds, and certain organic chemicals which were found to be injurious to apple foliage, nothing was found approaching lead arsenate in toxicity to codling-moth larvæ.

Further tests of chemically treated bands continue to indicate that these constitute a valuable adjunct to spraying. Work with these bands has been centered at Takoma Park, Md., and field testing has been done at a number of stations, including Yakima, Wash.; Wenatchee, Wash.; Vincennes, Ind.; Wichita, Kans.; and Bentonville, Ark. Bands treated with beta-naphthol, lubricating oil, and aluminum stearate have killed practically 100 per cent of all worms entering them. No evidence of a repellent effect has been found. Similar tests conducted by numerous State workers in cooperation with the Bureau of Entomology have corroborated these results. This season bands of various widths are being tested in order to determine the width most effective in trapping codling-moth larvæ.

The parasite survey which was undertaken some two years ago is being completed with the emergence in the spring of 1931 of material collected during 1930. In this way a great deal of information has been accumulated on the distribution and present importance of the various species of parasites of the codling moth in different parts of the country. One of the most important parasites in the Eastern States, *Ascogaster carpocapsae*, was found to be absent from most sections west of the Mississippi. Shipments of this parasite have already been made to Wichita, Kans., and Bentonville, Ark., in the effort to establish it at those points. While immediately measurable results are not expected, the presence of this parasite should prove a valuable factor tending to limit the codling-moth population. As already mentioned in previous reports, this parasite was introduced several years ago into the Pacific Northwest.

The studies of codling-moth biology at Bentonville, Ark., have been continued as previously outlined.

RELATION OF INSECTS TO PERENNIAL CANCER OF APPLE

Studies of the relation of insects to the perennial canker of apple, a fungous disease which seriously attacks certain varieties of apple in the Pacific Northwest, were undertaken at Wenatchee, Wash., in the spring of 1930. This disease assumes the form of cankers which originate in pruning or other wounds. The canker extends itself from year to year, and ultimately girdles and kills the twigs and branches. The cankers also provide an entrance point for rot fungi,

which hasten the death of large branches or of entire trees. The perennial canker fungus also causes a storage rot of mature fruit.

The cankers caused by this disease are usually infested by the woolly apple aphid (*Eriosoma lanigerum* Hausm.) and certain investigators of this disease believe that the woolly aphid is chiefly responsible for its spread and its persistence from year to year in the cankers.

The first object of the investigations under way is to determine the exact relation of the woolly aphid to the disease. Because of the mildness of the winter of 1930-31, the experiments which have been conducted thus far have failed to demonstrate this relationship, the disease being serious only after severe winters. On the assumption that the woolly aphid is at least an important factor, the investigations include studies of preventing woolly-aphid infestation in the cankers, by various means such as the use of paints, wound dressings, and so on.

As one possible means of reducing the woolly-aphid population in the Northwest, an effort is being made to introduce the parasite *Aphelinus mali* Hald. into that section. Several shipments of these parasites have been received through the courtesy of the Canadian parasite laboratory at Belleville, Ontario. The parasites received have been caged with colonies of the woolly aphid and it appears very probable that they will successfully establish themselves.

The status of a canker-infesting insect known as *Epicallima coloradella* Wals. in relation to the canker disease has also been studied.

OTHER APPLE INSECTS

Studies of the biology and control of the various species of apple leaf hoppers have been continued at the Bentonville, Ark., laboratory. One manuscript covering much of the work on these insects is already in press, and a second manuscript is to be submitted shortly. Studies are also being made at Bentonville of the giant root borer *Prionus imbricornis* L., which has become increasingly destructive to apple trees in northwestern Arkansas. The observations made in 1930 have revealed marked differences from the published accounts of the biology of this species. Numerous materials were tested for possible value in the control of this species, but only mercuric chloride gave any evidence of destroying the borers. During the present season experiments are being conducted on measures for the destruction of the adults.

In the Pacific Northwest serious outbreaks of the tarnished plant bug in orchards have occurred during the past two or three seasons. This bug hibernates in the adult stage, and emerges from its winter quarters in the early spring at a time when the buds of apple and other fruits are often the most attractive food material available. Its punctures cause many of the blossoms and the newly set fruit to drop off, and the fruit developing from the injured buds which remain is considerably distorted. This species breeds almost entirely on herbaceous vegetation, and the presence of alfalfa and sweetclover in or close to the orchards seems to have resulted in the building up of a very numerous population. Sweetclover in particular is too

valuable as a cover crop to permit recommending its elimination. The problem is being given as much attention as is permitted by the other work under way.

NUT INSECTS

PECAN NUT CASE-BEARER

The pecan nut case-bearer (*Acrobasis caryae* Grote), which was unusually abundant in the season of 1930 in many pecan sections, and which caused a further reduction of the light crop of nuts borne in the orchards in the southeastern part of the United States, has been practically absent this season in that section, although causing more or less damage in other areas.

As noted in last year's report, the nut case-bearer is not readily controlled by spraying or dusting with stomach poisons. Because of the serious losses which occurred in 1930 in the Southeastern States, the Albany, Ga., laboratory, in the late fall of 1930, undertook intensive studies of the biological control of this pest as well as of other pecan insects. The first activity undertaken has been the large-scale rearing of *Trichogramma minutum* Riley, and an attempt to utilize this parasite in the field to control the nut case-bearer. Up to the close of June a total of more than 13,000,000 *Trichogramma* had been reared, and liberations had been made in seven different orchards at appropriate times for the control of the eggs of this insect. Because of the virtual absence of the nut case-bearer, the results this season will be inconclusive as to practical control. At the Albany laboratory studies are also being made of *Phanerotoma tibialis* Hald., a parasite which oviposits in the eggs of the nut case-bearer and of numerous other pecan insects, the parasite later developing in the larvæ of the host insect.

Similar parasite studies are being conducted at the laboratory at Brownwood, Tex. In the Texas area the pecan groves consist mostly of native seedling growth in the river bottoms and along water-courses. Under these conditions biological control is of particular importance, and the utilization of *Trichogramma* under the semiarid conditions which exist there is being studied. Studies have also been made of 25 or more native parasites and predators of the nut case-bearer, many of which also attack the shuck worm and other pecan insects. These studies will prove of great value as a basis for subsequent work of a more intensive nature.

Experimental work with possible insecticidal means of control has been continued, chiefly in the use of contact materials against the eggs. Because of the extreme lightness of the infestation, the results this season have been inconclusive.

PECAN LEAF CASE-BEARER

Further experiments have confirmed earlier findings that Bordeaux mixture, 3-4-50, is a very satisfactory corrective for preventing foliage injury by lead arsenate in spraying pecans for the control of the leaf case-bearer (*Acrobasis palliolella* Rag.). Additional evidence was also obtained indicating that calcium arsenate, when used with Bordeaux mixture, is fully as safe and as effective as lead arsenate, at a considerable saving in cost. The combination

of Bordeaux mixture and calcium arsenate reduced the infestation in one test from 35 per cent to 3 per cent, and in a second series of plats from 36 per cent to 2 per cent.

HICKORY SHUCK WORM

This is another pecan insect which is not readily controllable by the usual stomach poisons, since it has feeding habits very similar to those of the nut case-bearer, as well as those of its near relative, the oriental fruit moth. Tests conducted at the Albany, Ga., laboratory on egg-destroying materials, including the highly refined oil sprays at 1 per cent, and lubricating-oil emulsion 1 per cent with nicotine sulphate 1-1,000, gave some reduction of infestation but not enough benefit to justify its cost.

Cultural methods offer the greatest promise of success in controlling the shuck worm, particularly the disposal of the shucks in which the insect passes the winter. Experiments with various harvesting practices are under way in order to work out the most effective and economical means of disposing of the shucks.

The possible utilization of *Trichogramma* in controlling the shuck worm is also being investigated, and experimental liberations have been made in several orchards.

PECAN WEEVIL

Cage experiments and field trials conducted at Experiment, Ga., have indicated that pecans may be protected from weevil attack by spraying with hydrated lime. In field tests, sprayed trees had an infestation of 2 per cent (including all nuts on trees, drops, and harvest, after July 24) as compared with 10 per cent infestation of unsprayed trees. Because of variations within the experimental plats, however, these tests must be repeated before conclusions may be drawn.

Throughout the period of their activity adult weevils are readily jarred from heavily infested trees, and damage to pecan nuts was appreciably lessened by this procedure. Jarring should be done at least once a week, with extra jarrings 24 to 48 hours after each rainfall of one-half inch or more. During the first half of the period, or up to September 1, it is necessary to strike only the limbs within 8 or 10 feet of the ground in order to get most of the weevils; after that time weevils are present at higher points in the trees. The insects can be jarred from the limbs by strokes that are not heavy enough to dislodge sound nuts. In an orchard of lightly infested trees, however, jarring did not prove profitable.

Studies of the effects of various systems of culture on the mortality of the larvæ after they leave the nuts are also being made.

OBSCURE SCALE

Studies of the obscure scale (*Chrysomphalus obscurus* Comst.) have been conducted at the Shreveport, La., laboratory. The biology of this insect under Louisiana conditions has now been worked out, and extensive records have been made of the parasites affecting it. Experimental spraying has demonstrated that oil emulsion should

be used at a strength of at least 6 per cent to control the obscure scale, and even this concentration does not give a perfect kill. A few pecan trees very heavily sprayed with a 6 per cent lubricating-oil emulsion in December were considerably injured, and slight injury occurred on a few trees similarly sprayed in February. No injury resulted from applications of oil emulsion at this strength on April 1. This suggests that pecan trees are less susceptible to oil injury as the close of the dormant period approaches, and that spraying for the obscure scale should be done in late spring.

OTHER PECAN INSECTS

Further attention has been given to the black pecan aphid, with particular reference to the possibility of reducing the cost of spray materials. Taxonomic and morphological studies of the various aphids affecting the pecan are being made at the station at Experiment, Ga.

Certain species of *Phylloxera* (chiefly *Phylloxera devastatrix* Pergande) have been found seriously injuring pecans in southern Louisiana. While it has been impossible to give this problem a great deal of attention, preliminary observations have been made. It is planned to conduct tests next year with applications of contact materials just as the buds are pushing out, since it is believed that the insect may be controlled by spraying at that time, before there has been opportunity for the formation of galls.

Observations are being made on the bottle leaf case-bearer (*Acrobasis cunulae* Heinrich), found on pecans comparatively recently, but quite abundant in the section south of Albany, Ga.

Leaf-feeding insects are often found damaging pecan foliage at about the time when the pistillate bloom is becoming evident, and immediate spray applications are needed to prevent further injury. This is particularly true in southern Louisiana. Many pecan growers have hesitated to spray at this time for fear of damaging the tender pistillate bloom. Detailed experiments conducted in the spring of 1931 have indicated that spraying may safely be done during the blooming period, if leaf-chewing insects are causing serious damage.

CHESTNUT WEEVILS

Further experiments with the use of hydrated lime in the control of chestnut weevils (*Curculio proboscideus* Fab. and *C. auriger* Casey) have given encouraging results. In experiments conducted at Bell Station, Md., two applications of a heavy lime spray, with the addition of a small quantity of fish-oil soap for a sticker, appeared to reduce the infestation from 44 per cent to less than 2 per cent. A single application made at Fairfax, Va., under conditions of very severe infestation gave a distinct reduction in the number of wormy chestnuts, although not enough to constitute satisfactory commercial control. It is believed that two applications would have given much better results.

Dusting with hydrated lime, as well as dusting with powdered talc, gave appreciable reductions in infestation. These materials, however, did not adhere so well as appears desirable.

BLUEBERRY MAGGOT

Dusting with calcium arsenate, now recommended for control of the blueberry maggot as a result of investigations conducted by the Bureau of Entomology, continued to give very satisfactory control during 1930, in the face of a severe infestation in untreated areas. Properly timed, two applications of calcium arsenate dust, at the rate of approximately 6 pounds per acre with each application, have given reductions in infestation ranging from 85 to 98 per cent.

The use of insecticide materials for the control of this pest is a rather new practice in the protection of native blueberries. Full information on present recommendations has been placed at the disposal of the blueberry growers of Maine by means of addresses at meetings, the preparation of a mimeographed circular which has been distributed by the University of Maine, and by personal contacts. A detailed publication reporting the results of the biological and control studies which have been made for a number of years is now in press, and a circular has been prepared summarizing the practical recommendations now being made.

The control experiments are being continued. This season they include tests of more dilute dusts, in which the calcium arsenate is mixed with an equal quantity or more of hydrated lime as a carrier. Copper carbonate, a dust containing arsenic, copper, and lime, and other materials are also being tested as possible substitutes for calcium arsenate. The arsenic-copper-lime dust is being tested as a control of both the maggot and leaf diseases, in cooperation with the Maine Agricultural Experiment Station.

Large plats, treated according to standard recommendations, are being maintained in order to confirm previous results and to check on the accuracy of the timing of the applications.

While the biological studies on the blueberry maggot have been practically completed, records are still being taken of the period of emergence and other important features of the pest's seasonal development. During the period 1926 to 1929 the flies emerged at practically the same dates, with variations of very few days from year to year. In 1930, however, the emergence was a week to 10 days earlier than had previously been observed. This information was given to the growers in order to assist them in timing their dust applications.

An interesting feature of the life-history studies was the discovery that some of the maggots remain in the ground through at least four winters, so that a few flies emerge each year from puparia that were formed in the ground four summers earlier. The emergence from puparia which have been two or more winters in the soil has been found to be five or six days later than the emergence from puparia which have spent only one winter in the soil.

Incidental studies are being made of other blueberry insects, particularly of a gall-making insect, *Hemadas nubilipennis* Ashmead, which is causing considerable damage in a few localities.

GRAPE INSECTS

The work with grape insects at Sandusky, Ohio, has been carried on in cooperation with the Ohio Agricultural Experiment Station.

Spray residue on grapes, resulting from the applications made for the control of the grape berry moth, continues to offer a problem of major importance in northern Ohio. Several fluorine compounds mentioned in last year's report, including the fluoaluminates of sodium, barium, and calcium, as well as the fluosilicates of the same elements, have been tested further, chiefly for foliage reactions. For the most part they have proved injurious to grape foliage. Several contact materials, including oil emulsions, nicotine sulphate, and derris and pyrethrum extracts, as well as rotenone, one of the most important active ingredients of derris, have been tested against the second brood of worms with very disappointing results. Experiments in modifying cultural methods which might aid in the control of the berry moth are being continued. Further study is needed, however, before recommendations can be made.

Because of the nature of the fruit, it has been found more difficult to remove arsenical residue from grapes than from apples. The Bureau of Entomology has continued to cooperate with representatives of the Food and Drug Administration and of the Bureau of Plant Industry in experiments on possible methods of residue removal. These experiments include spraying solvents on the fruit on the vines, as well as washing the grapes after harvest. This work has not reached the point where a practical method of removal can be recommended to the growers.

JAPANESE AND ASIATIC BEETLES

The reorganization, during the year, of the Japanese and Asiatic beetle work and the appointment of C. H. Hadley to its leadership by transfer from the Plant Quarantine and Control Administration have been mentioned. Shortly after the appointment of Mr. Hadley, the activities relating to these insects were grouped into the following sections:

Field supervision.—This unit includes the office of the division leader and is concerned with general administrative supervision over both investigational and business activities.

Maintenance.—The work falling under this unit is concerned with the general maintenance and upkeep of the physical plant, including buildings, grounds, and automotive and other equipment.

Biological investigations.—The activities included under this unit deal with the investigations of the insects and include not only studies on the life history and habits of the beetles but investigations on their movements, relative abundance, and activities.

Control investigations.—This unit deals with investigations to determine artificial methods of controlling or eradicating the Japanese and Asiatic beetles in any stage of their development. It includes the work on insecticides, attractants, and traps or other mechanical devices used in control of either the adult or immature stages.

Parasite investigations.—This unit deals with investigations in control of the Japanese and Asiatic beetles by natural enemies. Its activities include the introduction, colonization, and distribution of parasites from foreign countries; studies of native parasites or predators which attack these beetles; and investigations into the habits and development of the various natural enemies.

The investigations on the Japanese beetle were, as heretofore, conducted in cooperation with the Plant Quarantine and Control Administration. Close and friendly, although informal, cooperation has been continued with the New Jersey Agricultural Experiment Station and the New Jersey Department of Agriculture, as well as

with the Pennsylvania Department of Agriculture. On September 1, 1930, however, the financial aid for investigational work previously extended by the State of New Jersey was withdrawn.

JAPANESE BEETLE

BEETLE POPULATION IN THE OLDER INFESTED AREAS

The opinion, previously reported, that the Japanese-beetle population was no longer at its maximum in the sections of earliest infestations and that it was greater in more recently infested areas, received additional confirmation from the observations made during the season. The areas of present maximum infestation are located in sections on the margin of the general area in which the beetle was originally found and which was the first region to become heavily infested. The areas within which the Japanese beetles were sufficiently abundant to be generally injurious extended outward in New Jersey to such localities as Penningtown, Imlaystown, Browns Mills, New Lisbon, Hammonton, Malaga, and Pedricktown, while in Pennsylvania it extended as far as Lansdale, Valley Forge, Wayne, Media, and Chester. In the pine barrens district of New Jersey there was, however, apparently a decrease in population as compared with those of the seasons of 1927 and 1928. This decrease may be attributed to the recent dry summer in a section where the soil consists largely of coarse sand and gravel. Heavy localized infestations in the pine barrens were, however, observed at isolated points such as Cassville, Lakehurst, Bamber, Green Bank, and Bluebell, N. J.

Density in population of the beetle increased more slowly in high and hilly country than in the more level, low-lying sections. The northward extension of the area in which the beetle population is sufficiently dense to cause the area to be considered continuously occupied was more marked in New Jersey in a belt of low country extending diagonally northeast in the vicinity of Trenton and Hightstown toward Raritan Bay, and less general in the more elevated portions of the State lying above the fall line. The area in which the population is so dense that the area may be considered continuously occupied spread southward in New Jersey to the shores of Delaware Bay. In Pennsylvania the density of population increased more pronouncedly than in previous years, and the area of essentially continuous infestation was extended westward to West Chester, Downingtown, and Phoenixville and northward to the vicinity of Perkasio. However, throughout the heavily infested area where the density of population has become more or less stationary, soil infestation was substantially the same as in previous years.

EFFECT OF CLIMATIC FACTORS ON THE LIFE AND SEASONAL HISTORY OF THE JAPANESE BEETLE

Both the summer and fall of 1930 were unusually warm and dry, so that in favorable localities by far the greater proportion of the larvæ reached the last instar before cold weather. During the following spring an exceptionally small number of second-instar larvæ were encountered. The appearance of pupæ in the field in the spring of 1931 and the emergence of adults occurred almost precisely at the same date as in the preceding year.

Observations during the year indicate that a soil temperature of 50° F. is the threshold of larval activity, as there is a distinct correlation between this temperature and the periodical vertical movements of the larvæ within the soil.

The life and development of the egg and younger larval stages depend, at least to a large extent, on available soil moisture. Soil conditions at the time of oviposition and immediately following appear, therefore, to have a decided effect on relative abundance of grubs during the following season. During the summer of 1930 there was ample rainfall in June and July in the vicinity of Moorestown, N. J. The drought came later in the summer, at a time when the greater part of the larvæ had reached a stage where they were not so dependent on moisture. In the general vicinity of Moorestown moisture conditions at the critical stage of development were less favorable in 1929 than in 1930, with the result that the beetle population during the summer of 1930 was affected by unfavorable weather conditions to a greater degree than in the season of 1931. The exceptionally severe drought conditions during the summer of 1930 in the territory south and west of Philadelphia occurred, however, at a critical time in the development of the beetle and served to reduce the beetle population in this area during the summer of 1931.

Experiments conducted during the summer and fall indicate that the beetle eggs do not hatch at a temperature of 50° F. or below. Development within the egg does not start even at 54° F., but if the egg has been under favorable higher temperatures it will continue to develop and hatch at this temperature. These studies suggest that under field conditions in the generally infested area eggs will not hatch later than October 15 and that they will not survive the winter temperatures experienced even in southern New Jersey.

Cold and dryness are the two chief physical factors inhibiting spread and establishment of the beetle. Japanese-beetle larvæ are unable to stand any prolonged low temperatures below 10° F. Prolonged drought or unusually dry conditions at the time of oviposition and shortly thereafter are likewise inimical to the development of the beetle. Consideration of these and other facts suggests that the Japanese beetle would find highly favorable conditions for colonization in that section of the Atlantic coast extending from the vicinity of Portland, Me., southward to the vicinity of Wilmington, N. C., as well as in that portion of the country extending inland to the shores of Lakes Ontario, Erie, and Michigan, and southward through Ohio and western Kentucky to southern Virginia and western North Carolina. It is also fairly probable that the beetle will find a number of locations favorable for development at least as far westward as eastern Nebraska, Kansas, Oklahoma, and Texas, as well as in areas along the Gulf of Mexico.

LARVAL INSECTICIDES

Observations on approximately 750,000 evergreen and deciduous plants growing in plats in commercial nurseries in soil treated with acid lead arsenate indicate the wide variety of nursery stock that can be grown under these conditions. Among the plants which are growing successfully in treated soil are species of *Abies*, *Acer*,

Andromeda, Azalea, Berberis, Buxus, Cedrus, Chamaecyparis, Cryptomeria, Enkianthus, Euonymus, Ilex, Juniperus, Ligustrum, Leucothoe, Magnolia, Mahonia, Pieris, Picea, Pinus, Pseudotsuga, Rhododendron, Taxus, Thuja, Tsuga, and Viburnum. Certain kinds of nursery plants, including some species of Hydrangea, however, do not grow satisfactorily in soil treated with lead arsenate.

Investigations conducted with acid lead arsenate in cultivated soils show that the insecticidal action of this material is most effective when applied to the soil early in summer before the eggs hatch. The period over which this treatment is effective varies considerably, depending largely on the nature of the soil and the cultural practices.

The treatment of turf with acid lead arsenate continues to be the best method of controlling the larvæ of the Japanese beetle there. In view of the general use of this method, extensive investigation is being carried on with the object of obtaining further information on the different procedures of application, the use of fertilizers, the penetration and persistence of lead arsenate in sod land under different conditions, and the relative effectiveness of the treatment in different localities. A larval survey of the campus at Beaver College, Grey Towers, Glenside, Pa., where traps were run in conjunction with poisoned turf, shows that the average number of larvæ in the lead-arsenate-treated area was 2 to a square foot, while the average for the untreated area in that region was 20 to a square foot. In regions of heavy infestation the treated grass is generally darker and more vigorous than that in untreated areas.

Experiments designed to determine whether other stomach poisons would be effective insecticides in the soil were carried on during the summer. The main object of these experiments was to find a material which could be used around the roots of those varieties of plants which are sensitive to lead arsenate. It has been found that the borates are generally too toxic to be used in soil about the roots of nursery plants. The fluosilicates of barium, magnesium, potassium, and sodium are effective when freshly applied, although much slower in action than acid lead arsenate, but lose their insecticidal value after being in the soil for one year. Calcium fluosilicate has no value as a soil insecticide. The insecticidal action of the arsenates was only slightly lessened after being in soil for one year. Of the arsenates, aluminum arsenate, barium arsenate, dicalcium arsenate, tricalcium arsenate, iron arsenate, acid lead arsenate, magnesium arsenate, manganese arsenate, and zinc arsenate were found to be almost equally effective. The basic lead arsenate proved to be of little value in this connection.

In further experimentation with naphthalene as a fumigant for potting soil, it has been found that, unless the soil is held for several days after treatment to permit the chemical to disappear, the plants put into it are liable to severe injury.

In an effort to locate materials which could be used as dips or washes for nursery stock to destroy the immature stages of the beetle, tests have been made to determine the insecticidal value of emulsions of 110 liquid organic compounds, including alcohols, aldehydes, amines, hydrocarbons, nitriles, nitrates, halogens, sulphur compounds, and esters. The results with third-instar larvæ show that the most toxic dips contained allyl bromide, benzyl bromide,

chloroacetone, allyl isothiocyanate, ethyl isothiocyanate, methyl thiocyanate, methyl-alpha-naphthylamine, ethylnaphthylamine, or beta-beta-dichloroethyl carbonate.

INSECTICIDES FOR THE ADULT BEETLES

Extensive experiments were conducted with ethylene oxide as a fumigant to destroy adult Japanese beetles which might be present in boxes of raspberries, blackberries, or blueberries when the fruit is ready for shipment. It was found that fumigating fruit with ethylene oxide at the rate of 2 pounds per 1,000 cubic feet of space for two hours, with the temperature 75° F. or above, would destroy any adult Japanese beetles among the berries without causing any injury of commercial importance to the fruit. At 75° ethylene oxide is a gas and becomes immediately available as an insecticide. It has the advantage over carbon disulphide that the fire hazard is practically eliminated and no special vaporizing apparatus is required.

Tests were conducted to determine the relative effectiveness of different commercial forms of cyanides against the adult beetles in cars loaded with bananas. All types of materials tested were found to be effective and dosages and length of exposure have been determined. Under laboratory or control conditions it was found possible to fumigate wet and dry bananas without injury to the fruit, by holding it at a temperature of 75° F. for one hour. Only very small quantities of cyanide were absorbed by the fruit and the treatment did not impair its appearance or flavor, although holding it at the effective temperature hastened ripening to some extent.

CONTROL BY MECHANICAL MEANS

Tests were made to determine the value of mulch paper in preventing injury about nursery plants. From these tests it would appear that such means would reduce, but not eliminate, oviposition in the covered soil.

Investigations on traps were continued with the object of increasing their effectiveness. Observations during the season indicate that traps with white baffles and white funnels are more effective than traps with green baffles and green funnels. The present standard trap is more efficient without the ventilating system. Small traps are more effective, on the cost basis, than larger ones. From the season's observations it would appear that traps will decrease the number of beetles in an area but will not in themselves afford protection to the plants. When used in conjunction with the soil treatments the beetle population is, however, very greatly reduced.

WORK WITH PARASITES IN FOREIGN COUNTRIES.

Work on foreign parasites has been continued in Japan, and during the year shipments of the following parasites were received from that country:

<i>Tiphia vernalis</i> Roh.....	12,678 adults (about 90 per cent arrived alive).
<i>Tiphia ascricae</i> A. and J.....	11,258 cocoons.
<i>Tiphia popillivora</i> Roh. (Korean)---	335 cocoons.
<i>Dexia ventralis</i> Ald.....	20,500 parasitized <i>P. japonica</i> larvae.
<i>Centerter cinerea</i> Ald.....	10,000 approximately.
<i>Prosema siberita</i> Fab.....	900 parasitized <i>P. japonica</i> larvae.

Rather extensive scouting was carried on in Japan in areas which heretofore have not been examined, and one new parasite was discovered.

Explorations for possible parasites were also carried on in Australia, but as yet no promising parasite of the Japanese beetle has been located. Considerable information has, however, been obtained on the habits of *Ithone fusca* Newm., a species which has been recorded as predacious on scarabaeid beetles.

ESTABLISHED INTRODUCED PARASITES

Five species of parasites of the Japanese beetle, which have been introduced from time to time, have become established within the area infested. Three of these are flies, and none of them has yet been able to reproduce in sufficient quantities to be of any importance in reducing beetle populations. The other two are fossorial wasps and have already demonstrated their usefulness in limited areas.

Colonies of the fly parasite *Centeter cinerea* Ald. have been established at points within an area covering approximately 1,500 square miles. The natural spread of this species has been limited, and its distribution into outlying areas has been augmented by the liberation of colonies. The mean annual temperature of the Philadelphia region is from 7 to 10 degrees higher than the areas in Japan where this parasite is most abundant. This warmer temperature seems to cause the parasite to emerge two or three weeks in advance of its host. For this reason it is not expected that this parasite will be of economic importance in the present heavily infested area. The work on *C. cinerea* is to be discontinued until its host becomes abundant in climatic regions where the life history of the parasite synchronizes with that of its host.

During the summer of 1930 recoveries of the fly parasite *Prosema siberita* Fab. indicated a natural spread of approximately 1 mile from a center point of liberation, but the numerical increase of the species was limited. No recoveries were made, however, in areas where the species had been colonized in previous years. Climatic conditions within the area now generally infested by the Japanese beetle are apparently unfavorable for the rapid propagation of this species. Attempts made during the summer to reproduce it in insectaries and in field plats have not been very encouraging. It is therefore planned to discontinue work on this parasite at least for the time being. Preliminary studies to determine whether *Prosema siberita* would feed on the Asiatic beetle (*Anomala orientalis* Waterh.) or the Asiatic garden beetle (*Aserica castanea* Arrow) gave negative results for the Asiatic beetle but 14 per cent parasitism for the Asiatic garden beetle. Strangely enough, when the Asiatic garden beetle served as its host, a generation of the parasite was completed in 47 days, although under ordinary conditions there is only one generation a year.

The only colony of the parasite *Dexia ventralis* Ald. which has been established is located in the vicinity of Haddonfield, N. J. The species seems to have died out at all other colony centers. During the summer of 1930 somewhat more than 3,500 adults of this parasite were liberated in eight new areas within the vicinity of Chestnut Hill, Pa., where both the Japanese beetle and the Asiatic garden

beetle are abundant. It was hoped that the prevalence of grubs of these two species, both of which it successfully attacks, would aid in its establishment, but scouting during the following May and June gave only negative results. Studies on the habits of *Dexia* have shown that this species can be successfully reared on six species of scarabæoid larvæ, both native and introduced, which occur within this region. Because of its apparent inability to reproduce sufficiently to be of economic importance, foreign shipments of this species have been discontinued and the studies on its habits conducted in this country will be curtailed until the population of the Japanese beetle becomes abundant in climatic zones more favorable for the establishment of *Dexia*.

The localities of the 12 initial liberations of the wasp parasite *Tiphia vernalis* Roh. were scouted during 1930, and parasites were recovered in 6 of the areas involved. Extensive recoveries were made at Philmont, Pa., where the species is well established and rapidly increasing and spreading. Ten per cent of the grubs examined from this area were parasitized. During the summer of 1930, 7 new colony centers were started, 4 of these in Pennsylvania, 2 in New Jersey, and 1 in Long Island.

The three areas in which the original colonies of the wasp parasite *Tiphia popilliavora* Roh. were liberated in 1921 and 1922 are now united and cover about 4 square miles in the vicinity of Riverton, N. J., This area has been used as a source of supply for new colonies since 1927. During 1929, 1,000 females were taken from this center for liberation and a total of 147 colonies of this species have now been placed in the field. During August, 1930, the initial colony showed such depletion that large-scale collections were postponed. This depletion is considered to have been caused by the extensive collections and to the drought of 1929, which was detrimental to both host and parasite. During the summer it was possible to examine only 50 of the localities where colonies of *Tiphia popilliavora* have been liberated. Recoveries were made from 24 of these centers. The number of individuals in the colonies differed considerably. In 12 they were numerous and the colonies were fairly strong, one at Columbus, N. J., covering an area of half a square mile.

ASIATIC BEETLE

The dry weather during the summers of 1929 and 1930 caused a reduction in the numbers of Asiatic beetles (*Anomala orientalis* Waterh.). The season of 1931 was much more favorable, however, and the species is becoming increasingly abundant in all the areas in which it has become established. The Asiatic beetle overwinters as a grub deep in the sod land, moves upward in April, and feeds a short time before pupation. The period of adult emergence was substantially the same in 1930 as in 1929. The adult was present from about the middle of June to about the middle of August, being most abundant during the first week in July. During 1930 oviposition was first observed on July 2, and the greatest numbers of eggs were laid between July 18 and 30. During this 12-day period as many as 56 eggs per square foot were found at Jericho, N. Y. Later, because of dry conditions, the grubs became very scarce. The ground was so dry that eggs shriveled up and grubs either died or their

development was greatly retarded. Because the mild autumn permitted feeding over a longer period, those grubs which survived these conditions entered the winter about normal in size. When forced into hibernation in November, about 65 per cent of the grubs examined in Long Island were in the third instar, the remainder in the second. Not more than 90 per cent of these grubs complete their development in one year. The remainder become fully fed in late July or early August but do not complete their development until June of the following year. The grub of the Asiatic beetle is very active and, in addition to considerable vertical seasonal migration, there is apparently considerable lateral movement within the soil.

Prior to 1930 no injury by this beetle had been found elsewhere than in well-kept lawns. In 1930 grub injury was reported from gardens that had been under cultivation for a number of years. In some cases grubs had fed extensively on the roots of strawberries, corn, and raspberries.

ASIATIC GARDEN BEETLE

The drought of the summers of 1929 and 1930 also reduced the numbers of the Asiatic garden beetle (*Aserica castanea* Arrow), although the dry weather apparently affected this species less than it did the Asiatic beetle. This is apparently because of a difference in habits, as the Asiatic garden beetle flies largely at night and seeks moist places in which to find concealment from light. Oviposition apparently occurs largely in such places. Grubs of this beetle winter in sod lands at depths ranging from 8 to 17 inches and migrate to the surface for spring feeding about the middle of April. During 1930 about 70 per cent of the grubs found in April were in the third instar and the remainder in the second. They changed to pupæ about the last part of June or the first half of July. The first adult was noted two weeks later than the first had been found the previous year. Eggs were found in the field from July 3 to October 30, but they were more numerous between July 25 and August 10. In the spring of 1931 the grubs were much more abundant than they had been in previous years and adults were present after the middle of April. In the summer of 1931 the insect again increased in numbers and both adults and grubs were more abundant than during the previous two years. The grubs of the Asiatic garden beetle move both laterally and vertically in the soil. In cage tests grubs without food moved 34 inches in nine days while when food was present they traveled 20 to 30 inches in about the same time.

Prior to 1930 the injury caused by the grub of this species had been noticed only in lawns. During the summer of 1930, however, grub injury was reported in cultivated gardens. The larvæ were recorded as feeding on beet, begonia, corn, onion, and strawberry plants, and on nursery seedlings. By the end of September, 1931, grub injury was observed to be more general than in any year since investigations were started in 1927, both on turf and on many plants, including strawberries and young plants of beet, onion, and corn.

The adults of this species are attracted in large numbers to lights. They appear to be active and flying only when the temperature is 70° F. or over. At such times they sometimes fly to considerable heights and have been reported on the roofs of 30-story buildings

in New York City. Experiments with light traps show that the light given by a daylight bulb is much more attractive than that from clear or frosted bulbs. Although the light trap is still in an experimental stage, several owners of estates in the heavily infested area have erected them in an effort to reduce beetle population. Under favorable conditions large numbers of beetles have been collected.

During 1930 approximately 1,500 specimens of the wasp parasite *Tiphia asericæ* A. and J. were imported and liberated near Chestnut Hill, Pa. During May of that year parasitized *Aserica* larvæ were found 10 days later. Other liberations of this parasite were also made during 1930 at Westbury, Long Island. Scouting during May and June of the following year failed to recover any adult parasites in either Pennsylvania or Long Island.

CEREAL AND FORAGE INSECTS

The work on insects affecting cereal and forage crops is under the direction of W. H. Larrimer.

The more important older projects of this division are researches on the European corn borer, the Hessian fly, the corn earworm, the chinch bug, grasshoppers, the alfalfa weevil, and other primary pests of forage and grain crops. Newer projects, or the newer phases of older projects, concern the occurrence of the alfalfa weevil in southern Oregon, the diseaselike injury of alfalfa and other forage legumes caused by leaf hoppers in various sections of the country, the range caterpillar in northeastern New Mexico and the panhandle of Texas, and the control of the Mormon cricket in northwestern Colorado.

EUROPEAN CORN BORER

The necessity of preparing this report in midseason confines it, for the most part, to a summarization of the first half of the fiscal year, namely, the latter half of the season of 1930. The essential information on the season of 1931, including spread and population increase, includes data which can only be obtained subsequent to this report, much of it in the late summer and fall of the current year. The exceptional drought of the summer of 1930 affected the spread of the corn borer westward and southward and also reduced its numbers in the old areas of infestation. There was very little apparent spread of this insect westward. In Indiana the boundary of infestation remained practically as reported for 1929. In Ohio there was a slight extension southward into Clermont, Adams, and Pike Counties bordering on the Ohio River. Small extensions of this area project across the river into Bracken and Lewis Counties, Ky. There also occurred a southeasterly advance of about 10 miles along the Ohio River Valley into West Virginia. Elsewhere the spread of the corn borer in 1930 was almost negligible. Practically no commercial damage occurred during this year.

The surveys in the fall of 1930 indicated a reduction in numbers of the insect ranging from 20 per cent in Michigan to about 60 per cent in Ohio, with intermediate reductions in Pennsylvania and Ohio. These reductions were largely due to the death of eggs and

young larvæ when exposed to the sun by the wilting of the corn leaves.

The drought also caused the very young caterpillars to attack the ears of corn without feeding externally on the leaves. They sought the shelter of the crevices between leaf and stem immediately after hatching. A marked early migration to the lower portions of the stalk was later observed. Another remarkable effect of high temperatures with absence of moisture was the appearance of a few second-generation pupæ in this normally 1-generation area in Erie and Henry Counties, Ohio.

The spring surveys of 1931 indicate that existing infestation in the Great Lakes region is sufficient to cause serious trouble should the summer of 1931 prove unusually favorable to the insect. It was observed that there was considerably more corn débris remaining on the surface of the soil this spring than has been the case for several years past, and this condition is favorable to corn-borer survival and increase. In July high temperatures and abundant moisture prevailed in the region of the Great Lakes at the peak of the period of moth emergence and oviposition—conditions that are likely to bring increased infestation.

Progress in introduction of parasitic enemies of the corn borer has been excellent during 1930–31. About 750,000 of these parasites were liberated in various parts of the infested area. Extensive collections of corn-borer larvæ in such areas have shown that some of these introduced species are now destroying from 6 to 16 per cent of the borers present. To date there have been liberated a total of more than 2,500,000 of these parasites, comprising 19 species, of which 12 are known to have become established. Four of these were found during the year to be newly established in the region of the Great Lakes. Several important technical publications giving results of biological studies of some of these parasites were issued during the year.

The work on the cosmopolitan parasite *Trichogramma minutum* Riley was discontinued at the beginning of 1931, as it was found that the liberation of laboratory-bred material was inefficient owing to weather hazards, small area of dispersion, and lack of alternate hosts in much of the area under experimentation.

SOUTHWESTERN CORN BORER

The southwestern corn borer (*Diatraea grandiosella* Dyar) is believed to have entered the country from Mexico, and has become of major importance to corn culture in the Southwest. It was found to have extended its range from western Texas and New Mexico into the panhandle of Oklahoma. The indications are that eventually it will enter southern Kansas and that it may become an important pest of corn in the Mississippi Basin. Studies of the biology and control of the insect have been under way for several years.

RANGE CATERPILLAR

Although the cold, dry winter of 1929–30 killed nearly 50 per cent of the eggs of the range caterpillar, the stage in which it overwinters, no perceptible decrease in the number of caterpillars was

observed in northeastern New Mexico in the summer of 1930. This pest usually is held under control by a specific native egg parasite, *Anastatus semiflavus* Gahan, but at present this parasite has become much reduced in numbers. The result has been a widespread and serious outbreak of the range caterpillar, which has devoured the grass on much of the finest cattle range in the areas affected. The efforts of the bureau investigators during the past year have been directed chiefly toward the artificial multiplication of the controlling parasite. These efforts have been quite successful and in May, 1931, about 2,000,000 parasites of this species were liberated in the most heavily infested sections of the range country. It is planned to continue this work during the ensuing year.

ARMY WORM

During June, 1931, several outbreaks of the army worm occurred in the eastern half of the Mississippi Basin, and investigators of the bureau gave effective aid in Posey County, Ind., and Shelby County, Ky. The poisoned bait applied at their suggestion was very successful. A radio broadcast giving information on control was released through a Louisville broadcasting station immediately after the outbreak was reported to the Department of Agriculture.

GRASSHOPPERS

Following immediately upon two or three years which were favorable for grasshopper multiplication, very serious grasshopper outbreaks began to develop in various part of the western Mississippi Valley early in the spring of 1931. The grasshoppers were local species and the damage was in no instance the result of migrations from the western plains sloping from the Rocky Mountains, as was the case in the great grasshopper scourges of the seventies and eighties; in fact, the species involved in those early outbreaks, known as the Rocky Mountain locust, seems to have practically disappeared. The grasshoppers responsible for the outbreaks of this year were chiefly the 2-striped grasshopper and the differential grasshopper. Neither of these species is a migratory insect in the true sense, for both are rather heavy bodied and capable of only short flights.

The probability of heavy grasshopper outbreaks in the season of 1931 was recognized by the entomologists of the bureau, and predictions of such outbreaks were made in 1930; but, probably because of the economic situation, which had very seriously affected the income and resources of farmers of this district, very little preparation to meet the menace was made in advance. As a result, the damage was well under way and practically out of control before any very active work to limit losses was done. While more or less general damage and occasional heavy local injury occurred throughout the area, the most widespread and radical damage occurred in an area, 100 miles or more in extent, divided between southern South Dakota and northern Nebraska. Attempts to poison the grasshoppers in this and other areas were more or less futile because of a late start and in part because of the receipt and distribution of a commercial brand of poisoned bait which contained only half the

required strength of arsenic. In general the damage by the grasshoppers was little checked by such efforts.

The outlook in July, 1931, is that, with winter conditions favorable to the grasshopper, there is strong probability of a repetition of extensive grasshopper damage in 1932. To meet this situation the bureau is planning to cooperate with the State and local agencies in surveys this fall and winter to locate the areas in which eggs have been abundantly deposited, so that such areas can be cultivated by their owners or otherwise treated in such a manner as to expose the eggs to the killing action of winter. The bureau also plans to cooperate in preparing a program for poisoning the young hoppers early next season. No funds are available to give direct aid in such operations, but the forces of the bureau concerned in grasshopper investigations will be detailed to render all possible aid in making surveys and outlining and preparing control operations.

In response to many demands for aid during the outbreak of the current season, in the absence of funds for the purchase of poison, for labor, or for other direct assistance of this nature, the bureau devoted its available personnel to cooperation with the States and local agencies in advice and direction of such control efforts as were instituted very largely by the owners themselves or through the support of State or local funds.

ALFALFA WEEVIL

Surveys under way in July, 1931, indicate that the new infestation of the alfalfa weevil reported in the vicinity of Medford, Oreg., in the summer of 1930 has not spread materially during the past 12 months. In eastern Oregon, especially in Baker and Malheur Counties, the infestation, which formerly had been quite serious, was found to have diminished, and it was difficult for even the experts to find specimens of the insect. During 1930 a new infestation was discovered in Teton County, Idaho, and extensions of infestation in Colorado were observed but no new counties were invaded. In the older areas of infestation in Utah, a high percentage of parasitism by *Bathyplectes curculionis* Thoms., a species introduced from Europe by this bureau, was found to prevail. At the beginning of July, 1931, the damage from the alfalfa weevil in 1931, except in western Nevada and northern Utah, promises to be almost negligible.

SUGARCANE BORER

The sugarcane borer continues to be one of the principal limiting factors in the production of sugarcane in the Gulf States. Efforts toward control have been concentrated during the year in the introduction from South America of the insect parasites of this pest. Two species of parasitic enemies are being brought from Peru to New Orleans and liberated in large numbers. During 1930 about 180,000 specimens were introduced and in the spring of 1931 an additional 140,000 were received and liberated. Recently it has been found possible to transport these beneficial insects by airplane from Trujillo, Peru, direct to Miami, Fla., where, through cooperation with the Plant Quarantine and Control Administration, they are transhipped by train to New Orleans. By this procedure it was possible

to liberate the parasites on the sixth day after they left Peru, whereas formerly 22 days were required for this journey. This is believed to be the first time in history that parasitic enemies of insects have been transported by airplane from a foreign country to the United States.

BILLBUGS

For several years a comprehensive study of the billbugs injurious to cereal and forage crops has been under way at Webster Groves, Mo. The partial results of these studies have already appeared in a farmers' bulletin giving methods of control for most of the injurious species. This has been supplemented during the past year by the publication, in *Annals of the Entomological Society of America*, of an illustrated synoptic key to the known pupæ of the billbug genus *Calendra*, which renders it possible for the entomologist, without actually rearing the adult, to determine what species is under observation.

RED HARVESTER ANT

Although agriculture in the United States is not nearly so badly afflicted with herbivorous ants as is the case in many tropical countries, a few such species cause much annoyance and loss in the southwestern part of this country. Among these pests is the red harvester ant, found from south-central Texas westward to California. It denudes the surface of the soil in the immediate vicinity of its nests in cultivated and uncultivated fields, sometimes causing numerous bare areas each of which may be as much as 25 feet in diameter. It provisions its nest with the seeds of alfalfa and related plants, often removing a large portion of the crop in this way; and as it stings severely, this species can be considered a first-class pest. Studies of this ant have been in progress for several years, and as a result a farmers' bulletin giving satisfactory methods of control (the most effective being the use of carbon disulphide and London purple), as well as much other pertinent information, is in press.

CORN LEAF APHID

In the early years of its history the corn leaf aphid (*Aphis maidis* Fitch) was confused in the literature with a closely related species now known as the corn root aphid (*Anuraphis maidiradicis* Forbes). The biology of the corn-leaf form was obscure and little understood by entomologists, but as a result of studies pursued in the Southwestern States by bureau specialists most of the facts relating to the life processes of this pest have become known and are embodied in a manuscript recently submitted for publication through departmental channels.

SOD WEBWORMS

The studies of the principal economic species of sod webworms, carried on for many years in this division, were suspended on December 20, 1930, by the death of G. G. Ainslie, who was in charge of these investigations. During his service Mr. Ainslie's contributions to the knowledge of these important pests were many and valuable.

They consisted of a farmers' bulletin giving general control methods, and several technical publications detailing the biology and ecology of the more injurious species. His last contribution appeared as Technical Bulletin 173, The Bluegrass Webworm, published in February, 1930.

HESSIAN FLY

For many years it has been suspected that under some conditions the Hessian fly may exist indefinitely in native or other grasses. Conclusive experimental evidence to support this belief has, however, been lacking. The question has an important bearing on the control of the pest because, if the insect is always present in any numbers in wild host plants, regardless of the presence of the small grains, such host plants should be considered in planning any thorough scheme of control. To settle this point two bureau investigators, working independently in Indiana and Oregon, respectively, reared numerous individuals from wheat and then bred them into wild grasses; they then bred the progeny of such specimens back into wheat and produced fertile offspring. The results of one of these experiments have recently been published in the Journal of Agricultural Research.

As the seasonal history of the Hessian fly in the Pacific Northwest has been found to be quite different from that prevailing in the region east of the Rocky Mountains, particularly as to number and time of appearance of the generations, a publication treating on the biology of the insect in this region has been prepared and will appear through departmental channels.

LEAF HOPPERS AND ALFALFA

Excellent progress has been made in determining the character of the injury done to alfalfa and other legumes by leaf hoppers. It was originally believed that the insects acted as vectors of a specific disease that caused the condition commonly known as alfalfa yellows. The work done during the year, however, indicates that this condition results principally, if not entirely, from mechanical injury by the insects and loss of sap from their feeding. The species of plant hoppers chiefly responsible for these injuries have been determined and an investigation has been begun to ascertain whether certain varieties of legumes are resistant to the action of the insects, and, if so, why. Several technical publications detailing these results have been issued.

TRUCK CROP INSECTS

Investigations of vegetable and truck crop insects have been continued during the fiscal year under the general direction of J. E. Graf¹ and W. H. White.

BEAN INSECTS

MEXICAN BEAN BEETLE

In 1930 damage to the bean crop in the Eastern States by the Mexican bean beetle was checked by the abnormal season. The prolonged drought and high temperatures which prevailed depleted the popula-

¹ Resigned on Mar. 4, 1931.

tion of the beetle over the greater part of the affected area to such an extent that the use of control measures was limited. Although in general the percentage of beetles which survived the winter of 1930-31 was the highest on record, fewer beetles had entered hibernation in the fall of 1930 than in previous years. In 1931, consequently, the bean crop was little damaged by the first generation of beetles except in New Jersey, eastern Tennessee, and northern Alabama.

Less new territory was invaded in 1930 than in any other year since the appearance of the beetle in the East in 1920, the only appreciable spread being to the northeast in the New England States, where the beetle reached the central portion of Massachusetts.

Additional shipments of the parasite *Paradexodes epilachnae* Ald., a tachinid fly, were received from Mexico at the Columbus, Ohio, laboratory. From this material a large number of the adult flies were reared, and during the fall puparia of the fly were stored under various conditions, but none passed the winter successfully. This failure was anticipated because of previous experience, so an attempt was made to breed the parasite in the greenhouse throughout the winter. This was successfully accomplished and provided a stock of parasites, from which large numbers have been reared. It is planned to make liberations at several points in the infested area in the East and Southwest. Since the bean beetle belongs to the same insect family as beneficial lady beetles, tests have been made with the larvæ of seven species of native lady beetles to determine whether the parasite will attack beneficial species. Repeated trials, have demonstrated that the common lady beetles are not subject to parasitism by this tachinid, consequently it is believed that this parasite can be liberated without danger of its preying upon the beneficial species.

Extensive tests were conducted with fluorine compounds, principally barium fluosilicate, cryolite, and potassium fluoaluminate, but owing to the condition of the foliage throughout the greater part of the season no conclusive results as to the effect of these chemicals on bean foliage were obtained. The indications are that, when used in a dust form, these materials will not give such satisfactory control of the bean beetle as does magnesium arsenate or calcium arsenate, because they do not adhere to the foliage so well as do arsenical dusts.

A special study was made in cooperation with the Bureau of Chemistry and Soils to determine why some brands of calcium arsenate are more injurious to bean foliage than others. Chemical analysis did not reveal any factor that was directly responsible for toxic action of calcium arsenate on the bean foliage. Extensive tests in the laboratory, where bean plants were treated with calcium arsenate and held under different atmospheric conditions, show, however, that there is a direct relation between low atmospheric evaporation and injury to bean foliage from calcium arsenate. Temperature does not appear to be an important factor.

Various materials have been used in combination with calcium arsenate in an attempt to discover some means of rendering this chemical less toxic to bean foliage. Calcium sulphide proved to be a good corrective, but it was difficult to keep the combination in suspension. Copper-lime dust and sulphur are useful in this connection.

Experiments in commercial control, which have been conducted on the Eastern Shore of Maryland during the last two years, were reduced to a minimum as a result of the drought.

Since the bean beetle has increased in abundance in the Southwest during the last two years, particular attention has been directed to large-scale control experiments. The results show that calcium arsenate is the only practical remedy for use in the dry-farmed area of the Southwest, the chemical being comparatively inexpensive and its physical properties superior to those of the other commercial poisons. Because of the lack of atmospheric moisture in this area plant injury from calcium arsenate is not serious.

This season's studies on the hibernation and relative abundance of the beetle in the fields in this area confirm the results of the preceding six years' work, showing that rainfall stimulates and temperatures above 50° F. accelerate emergence of the beetle from hibernation. Permanent emergence rarely occurs when the daily temperature is below 50°. With information of this character at hand, the time of the initial infestation and the intensity of infestation in the fields can be determined—a very important factor from the control standpoint.

LIMA-BEAN POD BORER

A study of the Lima-bean pod borer (*Etiella schisticolor* Zeller) was initiated at Ventura, Calif., in August, 1930. The results thus far indicate that there is a possibility of controlling this insect with insecticides, since laboratory observations of the activities of the larva show that it moves about considerably over the bean plant before entering the pod and that after entering the pod it consumes pod tissue.

SWEETPOTATO WEEVIL

The cooperative control work on the sweetpotato weevil in southern Mississippi and Alabama during the year has yielded encouraging results. Further progress has been made in reducing the number of infested farms in Mississippi and also the intensity of infestations. The heaviest infestation reported in the 1930 crop was 2 per cent, and most of the reports showed less than 1 per cent. Not one infested farm has been found in Baldwin County, Ala., and the infested properties in Mobile County have been reduced from the original 114 to 1. It is reasonable to expect that this infestation will be wiped out in another season. Assistance has been extended to the States of Louisiana and Texas through the services of the leader of the project.

A motion-picture film showing the nature of the damage by the sweetpotato weevil and the measures which are taken to keep it under control is in preparation, and it is believed that this film will be of great value to the grower of sweetpotatoes.

WIREWORMS

Wireworm investigations have been continued in the West and South, a new laboratory having been established during the year at Fairfax, S. C., to undertake a study of the sand wireworms.

Although extensive experiments have been conducted in the West on the direct and indirect control of wireworms, no satisfactory remedy has yet been developed. These experiments, undertaken in cooperation with the Bureau of Agricultural Engineering, included the use of mechanical means such as steam sterilization and rotary plows. Tests with baits which involved the use of a large number of different types of poisons failed to yield satisfactory results. The poisons were mixed with whole-wheat flour, this material having proved to be attractive to wireworms, and the mixture was formed into balls.

Carbon disulphide is an effective soil fumigant against wireworms. The cost of treatment with this chemical, together with the absence of a ready means of application, limits its use. Lands properly treated with carbon disulphide will be free from damaging infestations for at least three seasons. This season's experiments have shown that carbon disulphide placed in 1-ounce dosages 4 inches deep and 24 inches apart will penetrate the soil and kill wireworms to a depth of 18 inches. This is especially true in sandy-loam soils when the moisture content is between 10 and 20 per cent. In the heavier clay-loam soils the wireworms are killed only in the top layer above the plow line. In a series of laboratory experiments, in which wireworms were placed in an atmosphere saturated with paradichlorobenzene and naphthalene, from five to six and one-half hours' exposure to paradichlorobenzene was required to kill 50 per cent of the worms, and with naphthalene eight hours was required to kill 40 per cent of the worms.

A large number of chemicals have been tried as attractants to the adult beetles. The outstanding result of these experiments was that caproic acid and butyric acid were attractive to the adult males of the species *Limonius canus* Lec. In a trap containing caproic acid 2,745 males and only 148 females were captured; in a trap baited with butyric acid 1,506 males and 145 females were taken.

In hibernation studies of the larvæ and adults it was shown that 94 per cent of the larvæ hibernated at a depth of 3 to 12 inches, 63 per cent of this number being found at a depth of 6 to 9 inches. Ninety-nine per cent of the adults were found at a depth of 3 to 9 inches, 54 per cent of this number being at a depth of 6 to 9 inches.

Additional studies have been made on the effect on the larvæ of submergence in water. These experiments bring out the fact that wireworms, both young and nearly grown, can withstand long periods of submergence without any apparent ill effects. Therefore flooding in irrigated sections would not be a practical means of reducing wireworm infestations.

Wireworm infestations seem to decrease, or at least do not build up so fast, in lands planted to alfalfa as in lands tilled throughout the season. Records taken on wireworm populations in land planted in alfalfa for four years show that this land has only one-half the number of wireworms as other fields planted continuously in truck crops. A large series of crop-rotation experiments to determine the value of farm practices as a means of checking wireworm damage has been started in Idaho.

In California it has been found that the number of eggs deposited by the females is greater than has hitherto been reported and that

the length of life of the wireworms may be less than three years. The rate of growth and length of life of wireworms are affected by temperature. With abundant food throughout the year, *Limonius californicus* Mann. may complete its development in two years under optimum conditions, whereas under field conditions three years or more are required. In an experiment eggs flooded for 25 days failed to hatch. Seventy-seven per cent of the eggs hatched after 5 days of flooding, 50 per cent after 10 days, and a little over 30 per cent after 20 days. An average of 90 per cent of the eggs that were held as checks hatched.

The study of the sand wireworm has not been in progress long enough to yield any definite results. Crop-rotation experiments, tests of crops for possible resistance to wireworm attack, and studies of the best planting dates as a means of reducing injury are under way.

An interesting result occurred in the experiments with baits. On the plat where 1,000 pounds of cottonseed to the half acre were applied two weeks prior to the planting of corn, the corn developed normally, and the indications are that a fair yield will be obtained. In the check plat, where rye was turned under several weeks before planting, the corn was seriously injured by wireworms. It would appear that there is some relationship between injury from this wireworm and the quantity of humus in the soil.

Wireworms, particularly the species *Heteroderes laurentii* Guer., are becoming of increasing importance to the vegetable industry of the South. Here, as in other sections, crop-rotation studies are being made, as this appears to be the most promising means of reducing injury on large acreages. The early potato crop of the South is particularly susceptible to injury and the principal loss to the grower is due to the lowering of the grade of the potato which bears feeding scars of wireworms.

SEED-CORN MAGGOT

The solution of the seed-corn maggot problem has developed to the point where it is believed that suberization of potato seed pieces prior to planting can be recommended to the grower as a means of reducing losses from this pest. Another season's work has shown quite conclusively that this treatment prevents injury by the seed-corn maggot and also that the commercial potato grower can satisfactorily suberize his seed pieces without much expense or additional time.

This insect is also a pest of seedling spinach on the eastern coastal plain. Experiments in its control as a pest of spinach have indicated definitely that organic fertilizer should not be used at the time of planting. If a fertilizer is necessary, it should not contain any organic matter, as such materials are attractive to the adult fly for egg deposition. Delay in the application of all fertilizers until the plants are past danger of injury from the seed-corn maggot has been adopted with good results by some growers in the Charleston, S. C., district.

The seed-corn maggot is most active in the South during the cooler months of the year. Consequently, the late spinach crop and the early potato crop are particularly subject to injury. Although extensive observations and experiments have been conducted, it has

not been determined in what location or in what stage the insect passes the summer. A few flies may be found throughout the summer months, but their numbers increase very rapidly with a drop of the temperature in the fall.

SPOTTED CUCUMBER BEETLE

Additional data gathered during the past season from a field study of the spotted cucumber beetle strongly indicate that this species breeds scantily in the South during the summer and that very few of those produced survive to account for the large winter population of the insect. There is evidence to show that the winter population in the South consists largely of beetles that emerge in the North during the fall and migrate southward. During 1930 the issuing peak of this fall brood at Muscatine, Iowa, was reached about September 25. Soon after issuing the beetles start southward, feeding on fall-flowering plants during the migration. The migration into Louisiana is completed about December 15, at which period the winter vegetable crops become infested. The beetles breed throughout the winter in the South, and with the approach of spring begin to move northward. Such migration is further indicated by attempts to carry the beetle over the winter in cages at Hartsburg, Mo., Muscatine, Iowa, and Elk River, Minn., which met with failure. In an attempt to trace their movement, more than 40,000 beetles were marked and immediately released. It is indicative that only a few of these were recovered in the fields where they were liberated. Three marked beetles were found about 2 miles south of the point of liberation.

With regard to the control of the pest, it has been observed that the broad bean is very attractive to the insect and therefore might serve as an excellent trap crop upon which the forms migrating in the fall could be killed as they collect. During the emergence period of the spring brood candytuft is a favored food of the males. Barium fluosilicate and potassium hexafluoroaluminate have given some promising results as a control but further tests under varying atmospheric conditions are necessary in order to determine the effect of these chemicals on the plant foliage.

BERRY INSECTS

STRAWBERRY WEEVIL

Further biological studies verify observations of the past season on the aestivation and hibernation periods of the strawberry weevil. After emergence from the pupal stage, which takes place during May and June, the adult starts feeding on the blossoms of a variety of plants in or about the strawberry field and continues to feed for 10 days to two weeks. Following this feeding period, the weevil seeks shelter in débris, usually somewhere in the immediate vicinity of the native food plant, to aestivate and hibernate. Apparently aestivation is not induced by a lack of suitable food, but takes place just as soon as sufficient food has been eaten to provide for the long rest period. Food is always abundant at the time the beetles become inactive.

Besides the control by sulphur arsenate dust, the value of winter clean-up of the waste areas immediately adjacent to berry fields as a means of preventing damage by the weevil has been demonstrated to many growers in the Chadbourn, N. C., district during the past season. Where winter quarters were cleaned up, injury to adjoining strawberry fields was slight.

The weevil occurred in unusually damaging numbers in Louisiana during the past season. It also occurred in injurious numbers in Mississippi. The damage in Louisiana was particularly severe, since it came after the crop had begun to bear and consequently calcium arsenate-sulphur mixture was not advocated as a control because of the danger of arserical residue on the ripening berries.

BERRY MITES

Cyclamen mite.—The cyclamen mite (*Tarsonemus pallidus* Banks)² was first recognized as a pest of strawberries in this country in 1928, when it was found in widely scattered plantings in the Northeastern States. It is now generally prevalent and destructive on the west coast, particularly in the Santa Clara Valley of California. Experiments have shown that the use of humid heat may become a satisfactory means of ridding nursery stock of this mite. In some preliminary experiments with an everbearing variety the plants were tied in bundles of 50 and exposed to a temperature of 110° F., temperature records being taken both at the center and at the outside of the bundles. In one test the bundles were exposed for one and one-half hours and in another for three hours. The temperature was reached in the outside of the bundles two hours earlier than in the centers, so the outer portions were heated for two hours longer than the centers. Untreated plants and the treated plants were set out in the field. It was evident some time later that the flower buds on the treated plants were damaged and it was also found that the roots had been seriously injured. In spite of this injury the plants recovered and made an excellent growth. They bore very little early fruit but developed considerable blossom later in the season. These plants were apparently freed of the mite, as the untreated plants showed a decidedly inferior growth and were heavily infested.

Red berry mite.—During the latter part of the season of 1930 the first serious outbreak of the red berry mite (*Eriophyes essigi* Hassan) occurred in the main blackberry-growing districts of Oregon and Washington. A thorough survey of the damage caused by the mite in these States revealed three infested areas, one in southern Oregon, one in the Willamette Valley, and the third between Tacoma and Seattle, Wash. Near Woodbury, Oreg., 95 per cent of the crop was lost in a number of fields. Heavily infested berries did not ripen, and in the case of light infestations the fruit was unsatisfactory for canning because of its color and flavor. Control experiments with lime-sulphur and oil sprays were undertaken during the dormant season, but it is too early to determine the results.

² There is some question as to whether the species concerned here is *pallidus* Banks or *fragariae* Zimm.

European raspberry mite.—This mite, *Eriophyes gracilis* Nal., was rather abundant and of wide distribution in the Puyallup, Wash., district on raspberry, thimbleberry, and salmonberry. It overwinters in the buds and apparently is not fully dormant, but injures the buds during the winter. Studies of the life cycle and control of this pest are being made.

PEA APHID

The work on the pea aphid consisted in a study of the factors responsible for outbreaks and the relation between infestations and crop losses, such information to be used as a basis for control measures.

It appears that variations in moisture content of the plant, in sap concentration, and in the soil moisture have little relation to aphid abundance, but that the rate of aphid reproduction and the fluctuations in infestations during the season are closely related to the temperature. A careful study of the natural enemies of the aphid has made it more evident than formerly that they are also secondary in importance to weather in determining the intensity of aphid infestations. Studies on egg development show that only about 22 to 35 per cent of the overwintering eggs hatch and that, if eggs are exposed, without covering, to fluctuations of winter temperature, or if they are covered too heavily, the number which hatch is considerably smaller.

CELERY LEAF TIER

An intensive effort was made in 1930 to determine the summer habits of the celery leaf tier, but without obtaining conclusive results. There is evidence that in the cultivated areas breeding of the leaf tier continues to a limited extent throughout the summer, but whether or not this development is great enough to account for the large number of moths that appear in the celery seed beds in the fall at the first drop in temperature is doubtful. Last fall in the Sanford, Fla., district the season was abnormally cool and the first moth was found in the celery seed bed on September 30, when the mean temperature dropped to 77° F. The weather continued cool, with the result that there was a steady influx of moths into the celery beds throughout October. This appearance of the moths was one week later than in the previous two seasons. In the case of two earlier years, however, after the first influx about the third week in September, no moths appeared until after the next drop in temperature, which occurred during the first week of October.

The abnormally cool and wet weather which prevailed throughout the winter served to check the development of the celery leaf tier to a point at which it was unnecessary to employ control measures against it.

Control tests with pyrethrum indicated that neither hydrated lime nor sulphur should be mixed with the pyrethrum powder until shortly before it is to be used. The toxicity of such mixtures was reduced materially after they had been held for a considerable period.

The rearing of the parasite *Trichogramma minutum* Riley, using eggs of the Angoumois grain moth as hosts, has been continued, but without encouraging results. The extreme difficulty of keeping the

moth-breeding room free from mites and the red flour beetles makes the rearing of the parasites a complicated problem. Sulphur has been used as a means of reducing the mite populations, and is of some benefit in this connection, but unfortunately it reacts similarly on the parasite. Approximately 2,000,000 parasites were reared last year, most of which were used in storage experiments and in the maintenance of stocks. Rearing experiments carried on since October, 1929, to determine the effect of long-continued breeding under artificial conditions show that parasites reared in cages which permitted the entrance of all sun rays, and kept at room temperature in an indoor rearing room equipped with windows of ordinary glass, reached the fifty-fourth generation without any noticeable effects. Out of doors in similar cages the parasites have reached the forty-first generation with the same result. This parasite was active throughout the winter months, even during the abnormally cool weather of last year. Parasitism of leaf tier eggs ranged from about 3 per cent in November to 0.75 per cent in January, the percentage of parasitism being lowest between December and March.

EUROPEAN EARWIG

The European earwig continues to be a nuisance in the affected areas of Washington and Oregon and also in Rhode Island. Further studies on its food habits confirm the liking of the earwig for a diet of both animal and vegetable matter—as to the latter, it showing a preference for moss and lichens when they are available. It does, however, vary its diet according to the available food supply. Repeated reports of damage to cloth by earwigs have been received, but numerous tests with cotton and woolen cloth, both starched and unstarched and treated with fish oil, have demonstrated that the earwig will not feed upon these materials. The fish oil was added as an attractant, since in last season's work the earwig had shown a fondness for baits mixed with this oil.

Evaporation records taken with atmometer cups at 14 points in Oregon and Washington indicate that the European earwig is able to survive only in sections where the evaporation is usually below 200 cubic centimeters per week, except where some outside influence might affect atmospheric conditions. For instance, in the Hood River, Oreg., district evaporation was well over 300 cubic centimeters per week for the duration of the experiments, and at Corvallis, Oreg., it was well over 200 cubic centimeters during half of the period of observation, yet the earwig was able to survive in both of these locations. It is believed that the breeze from the ocean which follows up the Columbia River to points upstream from Hood River, and through a break in the mountains to the west, blows across a narrow strip, including Corvallis, and that this explains the survival of the earwig in this section. A transverse belt of earwig infestations is found in the Corvallis area, and this marks the southern limit of earwig abundance. At Hermiston, Oreg., the evaporation usually was well over 300 cubic centimeters, and one week it reached a peak of 432 cubic centimeters. Earwigs were able to survive here, however, because of subirrigation of the cage in which they were held. A similar condition obtained at Union, Oreg.

These instances may explain the survival of earwigs in irrigated areas about Yakima, Wash.

Fifty-four poisons, including 24 arsenicals, 17 fluorides, 5 silico-fluorides, and 8 miscellaneous compounds, have been tested in bran-fish-oil baits. Potassium silicofluoride was found to be the most effective poison, with sodium silicofluoride second, and sodium fluoride third. Of the 10 most effective poisons, Paris green was the only arsenical and it ranked sixth in this group. As already indicated, fish oil is distinctly attractive to earwigs and is recommended as an ingredient of the bait.

In order to determine the effect on poultry of earwig bait containing fluorine, an experiment was conducted wherein six chickens weighing 1.3 pounds each were confined and fed entirely upon the earwig bait with the addition of meat meal to balance the ration. A chicken was removed from the coop each day. None died after being in the coop 70 hours; one death occurred after 84 hours, and another after 114 hours. The surviving chickens which had eaten the bait during their confinement for 22, 46, 70, and 114 hours, respectively, were kept under observation for two months and apparently developed normally, with one exception—that of a chick that had been in the coop for only 22 hours. It appears that there is little danger of injury to poultry from the usual application of earwig bait, as the chickens in this experiment consumed far more bait in 24 hours than would be eaten by fowls under the manner of its distribution for the control of earwigs.

VEGETABLE WEEVIL

The vegetable weevil is becoming more of a major pest of vegetables in the South each year. It is now known to occur in Mississippi, Florida, Louisiana, Texas, and Alabama. In Mississippi, Florida, and Texas four new counties became infested last year and two additional parishes were found in Louisiana.

The weevil has a wide range of food plants, including many wild species, 20 of which were first observed last year to serve as food for the weevil. A large number of these plants had been previously tested in the laboratory as possible food for the weevil. The indications, particularly since these plants have been available to the weevil since its introduction into the South, are that the food habits of the weevil are changing and that it is fast adapting itself to its new environment.

Sodium fluosilicate has given good results as a poison when incorporated in baits. Arsenicals may be used effectively on plant foliage that is not to be used for food.

In California the vegetable weevil continues to thrive in the infested areas in the vicinity of San Jose. The beetles become active about the first week in October and breed throughout the winter, but by the last of May have practically disappeared.

Barium fluosilicate has been used successfully in control of the pest, especially on carrots. This chemical does not act so quickly as sodium fluosilicate, but the latter must be used moderately or the plant is liable to injury. Sodium fluosilicate has proved to be very harmful to potato foliage, but it has been applied to tomatoes without injury.

Cleaning up grass and other débris along fence rows during the aestivation period has served to delay infestations on cultivated crops in the adjoining fields for about two weeks.

TOBACCO INSECTS

TOBACCO HORNWORMS

Although the chemotropic method of control (i. e., by attractants) of the hornworm moths is still in the experimental stage, the results obtained have been encouraging. An improved moth feeder has been devised which permits slow evaporation of the attractive substance, amyl salicylate. Tartar emetic is used as the poison with the attractant. The abnormally dry season of last summer apparently reduced the numbers of the hornworm, as only late tobacco was infested to any extent. This year the moth feeders are being used at the rate of one to every 3 acres, whereas last year only one trap was used to 9 acres, and better control is resulting.

TOBACCO FLEA BEETLE

The tobacco flea beetle is still a major pest of tobacco grown under shade in Florida. Laboratory experiments and small-scale field tests conducted during the latter part of the season of 1930 indicated that from the standpoint of toxicity to the beetle and also that of safety to the tobacco plant, barium fluosilicate might be useful as a means of control.

Dusting tests with well-powdered barium fluosilicate early in the season of 1931 gave good control of the flea beetle without injury to the tobacco foliage. Under commercial conditions two applications of the barium fluosilicate were made at the rate of 4 pounds per acre with exceptionally good results. About 75 acres of shade-grown tobacco were thus treated. If subsequent results substantiate those already obtained, it is believed that definite recommendations regarding the use of barium fluosilicate for control of the flea beetle can be issued to tobacco growers.

TOBACCO STALK BORER

Further work with the tobacco stalk borer has shown this insect to be very resistant. It may live two weeks or longer completely submerged in water, as long as 70 days without feeding if water is available, and two weeks or longer without food or water. Tests conducted with different types of tobacco indicate that the variety Maryland Mammoth, an unusually vigorous type, is the most resistant to attack by the borer. *Nicotiana rustica*, one of the first tobaccos tested in the Southwest as a source of nicotine, has had to be discarded because of its susceptibility to attack. In the direct-control experiments lead arsenate appears to be repellent to the stalk borer, but does not kill so quickly as either Paris green or some of the fluorine compounds.

BLACK EUROPEAN SLUG

The black European slug made its first appearance as a pest of tobacco seed beds on the Carolina coastal plain in the early spring of 1919. Its injury was widespread and serious, and since that time

it has caused damage each season. The slugs feed at night and may destroy most of the plants in a bed before their presence is detected. The beds can be protected from them by the use of hydrated or air-slaked lime. If the slugs spend the day outside the bed and enter it at night to feed, a lime-dust barrier gives good protection. Such a barrier should be from 4 to 6 inches wide and replaced as often as necessary to keep it in the form of dust. If the slugs remain in the bed during the day, thorough dusting of the plants with the lime is effective in preventing injury.

PEPPER WEEVIL

The effect of winter temperatures and winter host-plant survival on the pepper weevil has been the subject of considerable study during the year. In general a minimum winter temperature of 28° F. or above permits such growth of the nightshade plants, the common and most abundant winter host of the pepper weevil in California, as will carry a large weevil population through the winter. Minimum winter temperatures of 30° or above permit nightshade and peppers to blossom and set fruit, thus furnishing the pepper weevil with places in which to breed and become more numerous by early summer. Minimum temperatures of 18° for short periods will kill unprotected nightshade and peppers.

The object of the later control studies has been to find substitutes for calcium arsenate. Some fluorine compounds have been tested extensively. Synthetic cryolite gave an average kill of 92 per cent of the weevils in 48 hours. When the cryolite was diluted with equal parts of talc, the average kill in a like period was 86 per cent. In 18 experiments with barium fluosilicate 65 per cent of the weevils were killed in 48 hours, while in 4 experiments calcium arsenate gave an average kill of 52 per cent during the same time. A few growers tested barium fluosilicate and, while no provision was made for making comparisons with untreated plats, weevil infestations did not increase materially where several applications had been made. No plant injury resulted from these treatments. It will be necessary to continue the experiments before drawing any definite conclusions on the exact value of either barium fluosilicate or cryolite as a control for the pepper weevil.

MOLE CRICKETS

The Porto Rico mole cricket (*Scapteriscus vicinus* Scudd.) and another species, *S. acletus* Rehn and Hebard, are becoming important pests on the eastern coastal plain and in the Gulf region, by damaging vegetable seedlings in the field and in seed beds. During the past season the latter species was particularly injurious in the winter-grown celery area of Sanford, Fla. In many instances large areas of the celery seed beds were destroyed by the insects burrowing through just below the surface of the soil. The pest was so abundant in some beds that it was necessary to apply a poisoned bait almost every day in order to protect the sprouting seed. In order to check the ravages of this insect in the celery-growing area, a more effective bait is needed, as well as baiting throughout the invaded area to prevent continued reinfestation.

The crickets may be present at any season of the year, but from February through June, when mating and egg deposition take place, they are found in greatest numbers. There is only one generation or brood annually. Fertilizers appear to be an important factor in restricting the crickets to certain areas, but this phase needs further investigation. Soil moisture and soil temperature are also important factors.

BEET LEAF HOPPER

The search for ways and means of controlling the beet leaf hopper has been continued in cooperation with the States of Idaho, Utah, and California. There had seemed to be good reasons for expecting only a light infestation in 1930 in Twin Falls, Jerome, Minidoka, and Cassia Counties, Idaho, but a heavy movement of the leaf hoppers from the Northwest, a hitherto unsuspected source of these insects, upset all calculations on the amount of leaf-hopper damage to be expected. As a result, low tonnages of sugar beets were general throughout the affected area. When the leaf hoppers arrived in the fields and it was apparent that injury would be severe, many beet plantings were plowed up under the direction of bureau workers and other crops were substituted, thus avoiding a total loss of return from the land. The southern breeding area, from which for several years had been collected data on which to base predictions of leaf-hopper abundance, contained only low insect populations until late in the summer. The experience early in the season of 1931 adds to the evidence that predictions based on data collected on leaf-hopper conditions during the winter and early spring are uncertain. As illustrated by this year's experience, the data on the hibernation of the leaf hopper collected during the winter and early spring indicated rather clearly that there would be heavy migrations to the cultivated areas; yet, because of the severe spring drought, which killed the mustards, breeding of the leaf hopper in the desert area was checked, and consequently its flight up to the third week in June was not so great as had been indicated by the overwintering populations. The leaf hoppers which entered the cultivated areas in May and June caused considerable disease in the beet fields, but the development of the disease was retarded by the cool June weather, and the beets have made a good growth. It is too early at this time to give the final effects of this year's leaf-hopper attack on the beet yield, but a large proportion of the beet fields have dangerously high populations of leaf hoppers.

The weather-vane trap devised last year was employed extensively during the present year. Approximately 100 of these traps have been placed over the territory to intercept any insects in flight from various areas on which mustards grow. That the hoppers are again coming from the South and Southwest, contrary to last season's movement, is shown definitely by these traps as well as by the distribution of the insects in the beet fields. The data from the traps also show that the insects' dispersal from the desert areas to the cultivated fields, instead of taking place in movements of short duration, extends over a considerable period.

Direct-control studies both in the laboratory and in the field have been both intensive and extensive. Various substances have been tested as attractants and repellents, but without positive results.

Either the leaf hopper is not responsive to chemotropic stimuli or else experimental methods are yet too imperfect to reveal any reaction to chemicals on its part. The phototropic studies indicate, however, that the leaf hopper is very sensitive to light and responds to very slight differences in its intensity, the responses increasing with the intensity of the illumination within the limits covered by the tests.

An oil-pyrethrum spray has been tested to determine its efficiency as a means of controlling the leaf hopper in the beet fields. In these tests, with large leaf-hopper populations—that is, from 25 to 35 adult insects per plant—a kill of 80 per cent was obtainable. Even with this large percentage of mortality at least five to seven leaf hoppers per plant survived, so the infestation is still very dangerous from the standpoint of disease dissemination. A second application of spray reduced the number of leaf hoppers per plant to four or five. It is evident that little economic control was achieved under these conditions. Additional tests were made with calcium cyanide and other dust insecticides, and although the data thus far accumulated are not sufficient to permit definite conclusions, the indications are that the control of the leaf hopper in the beet fields by the insecticides tested is not practicable.

Another phase of control work which has received considerable attention during the year is the use of insecticides in the desert breeding grounds of the leaf hopper prior to its early summer migration. Evaluation of this method of control depends upon a thorough knowledge of the location, type, and limits of the breeding grounds involved and also the percentage of kill obtainable. Through cooperation with the University of Idaho the workers on this problem have been able to obtain information on the insect's activity in western Idaho which is essential to the work at Twin Falls. The movements of the leaf hopper in Utah throughout the year have been followed through the cooperation of the Utah Agricultural College.

The data on parasites obtained this year give a better knowledge of the limiting factors on the effectiveness of the egg parasite *Aphelinoides plutella* Gir., and also on the influence of the presence of Russian thistle (*Salsola pestifer* A. Nelson) on the percentage and distribution of this egg parasite. This parasite overwinters in Russian thistle more abundantly than in any other plant. The data collected on the distribution of this weed may explain the uneven distribution of the parasite through the desert area.

COTTON INSECTS

Investigations on insects attacking the cotton plant were carried on under the direction of B. R. Coad until January, 1931. Following the severance of Mr. Coad's connection with the department F. C. Bishopp, in addition to directing the work of the Division of Insects Affecting Man and Animals, acted in charge of the Division of Cotton Insects during the rest of the year. R. W. Harned, formerly of the Mississippi State Plant Board, was selected as leader of the bureau's work on cotton insects and reported for duty June 20. Although there was a curtailment in certain activities, the work of the division as a whole followed along much the same lines as in the preceding year.

BOLL WEEVIL

Observations on hibernation, winter survival, and resulting damage by the boll weevil were continued at several points in the Cotton Belt, some of this work being in cooperation with various State experiment stations. The average survival of boll weevils in nature, as determined from the examination of Spanish moss, made during the spring of 1930, was 0.02 live weevils per ton of moss. The survival in hibernation cages was 0.01 per cent of the number of weevils installed. This was low as compared with the average survival at Tallulah, La., which was approximately 1 per cent as determined over a long period of years. Boll-weevil infestation and damage throughout the Cotton Belt was much less than normal, yet great in the aggregate. The reduction in weevil damage seemed to be due to the low survival of weevils during the winter of 1929-30 and the extremely dry weather which prevailed over much of the Cotton Belt in the summer of 1930.

The relatively small damage caused by the pest in the vicinity of Tallulah is indicated by the fact that the average gain in seed cotton secured by the application of calcium arsenate to field plats was 105 pounds per acre, an increase of only 9.3 per cent, which is far below the average obtained in experiments during the past several years.

Cooperative work in South Carolina and Georgia has again demonstrated its usefulness to cotton farmers in these States. The hibernation, infestation, and spread of the boll weevil have been determined systematically, and through the extension agencies of the States concerned the cotton growers have been acquainted with conditions. These detailed observations have not only assembled much basic information but have made possible recommendations which would put control operations on an intelligent and substantial basis. When field observations indicated that the weevil was not sufficiently abundant to cause damage, the growers were so advised and were thus able to effect distinct savings by withholding applications of calcium arsenate.

A series of control experiments were carried out at Florence, S. C., in which the early application of poisoned molasses was followed by calcium arsenate dust where the infestation of the boll weevil had attained 10 per cent. Although boll weevils were less numerous than usual, some interesting results were obtained from tests conducted in experimental plats. In these experiments three early applications of poisoned molasses alone showed an increase in yield over similar untreated areas at the rate of 24 pounds of seed cotton per acre. In experimental plats where calcium arsenate was the only insecticide used, five applications of calcium arsenate dust increased the yield over that of similar untreated areas at the rate of 356 pounds of seed cotton per acre. In experimental plats which were given the combination of the two treatments—i. e., three early applications of poisoned molasses followed by five applications of calcium arsenate dust—the yield from the experimental plats was increased at the rate of 640 pounds of seed cotton per acre.

During the year some reports came from South Carolina indicating that such crops as cotton, soybeans, and oats were injured by the presence in the soil of arsenic from previous applications of calcium arsenate to cotton for the control of the boll weevil. Co-

operative investigations have been arranged between the Bureau of Entomology and the South Carolina Agricultural Experiment Station to determine the facts in this matter. Preliminary inquiry indicates that the injury is apparent only on light sandy soils and where applications of excessive quantities of calcium arsenate have been made. A large number of soil samples from fields in which crops were damaged and from other fields where no poison had been applied were analyzed. Samples from fields in northeastern Louisiana which had received heavy applications of calcium arsenate and from others which had not been poisoned were also analyzed. These analyses showed that samples of soil from South Carolina taken from fields in which damage was reported had an arsenic content varying from 5 to 100 parts per million, while one sample of virgin soil showed an arsenic content of 10 parts per million. In northeastern Louisiana samples of soil from fields which had received heavy dosages of calcium arsenate with no apparent injury to the crops were found to vary in arsenic content from 40 to 120 parts per million. The several factors which appear to be responsible for this damage are not well known. It is certain, however, that the recommendations of the bureau with reference to the frequency of applications and quantity of calcium arsenate to be applied should be very closely followed.

Studies of boll-weevil migration at Tallulah, La., and Florence, S. C., have been of value in connection with determining the date on which late-summer applications of poison will cease to increase the yield of cotton.

Investigations of dusting machinery for the purpose of improving machines of various types, especially in their adaptability to distributing various kinds of insecticides, were carried on throughout the year. A number of dusting machines were calibrated and otherwise tested to secure basic information on the principles of their design and operation. These tests have led to the conclusion that the design of the dust hopper is very important in securing uniform distribution with varying amounts of poison in the hopper. Good progress has been made on designs for a hopper to meet these requirements. Attention has also been given to more efficient utilization of the higher-velocity principle in both the small dusters and the large motor-driven dusting machines. An effort has been made to develop a duster to be attached to cultivators, and some models of this type are now under practical test. Further studies of the width of the poison strips effectually covered by various types of dusters have been made. This has an important bearing on effective coverage of the plants without wasting poison. These tests have been conducted with calcium arsenate, nicotine sulphate dust, and Paris green, materials which are now widely used in the control of cotton insects.

THURBERIA WEEVIL

Life-history and seasonal-history studies of the *Thurberia* weevil, with special reference to its adaptation to plantings of cultivated cotton in Arizona, were continued. The weevils used for these investigations had been bred in cultivated cotton since the crop of 1926—that is, they had been removed from the native host plant four years. Into an isolated 1-acre field near Tucson 230 weevils

reared on cultivated cotton were introduced during the period from July 8 to 31. In this plot the maximum square infestation of 11.4 per cent was reached on July 22 and the maximum boll infestation of 25.2 per cent was reached on August 28. No appreciable difference was noted in the life history and behavior of the weevils bred for four years on cultivated cotton as compared with those bred on *Thurberia* plants in cages. Early in the season a slight preference for squares was noted, but later there was a decided preference for bolls. Preference for bolls for feeding and breeding was more pronounced in the open field than under cage conditions. Only two generations of the weevil developed during the season. Hibernation studies were continued under different conditions, and it was found that about 64 per cent of 387 weevils found in about 10,000 bolls were alive when these examinations were made on March 4 to 6.

The freedom with which the weevils transfer their attack from the native *Thurberia* plants to cotton was demonstrated in a field of Egyptian cotton grown on the Papago Indian Reservation, where no cultivated cotton had been grown previously. Infestation counts were made at regular intervals throughout the season. By October, 34 per cent of all bolls in the field were found to be infested. Field inspections were made at the end of the growing season to determine the development and spread of the insect. All cotton areas in the Santa Cruz Valley were found to be infested, but there was a decided decrease in weevil population as compared with that of the past few years. This condition was apparently due to the comparatively light rainfall in the mountains and the general poisoning of cotton for the control of the cotton leaf worm.

COTTON FLEA HOPPER

The so-called cotton flea hopper and certain related insects continue to be an important problem in many parts of the South. A considerable number of insecticides were tested during the year. One of the most noteworthy discoveries was the fact that a mixture of Paris green and calcium arsenate dusted on infested cotton kills large numbers of the adult hoppers. Sodium fluosilicate was found to be effective against the adults but less so against the nymphs. Four per cent nicotine sulphate in calcium arsenate dust was highly effective against both nymphs and adults. Various grades of sulphur were found to be much more effective against the nymphs than against the adults. The very fine dusting sulphurs were much more destructive to the insects than was flowers of sulphur.

Cage tests with various species of hemipterous insects have shown definitely that about a dozen species may cause the so-called hopper damage. Observations in the field, however, indicate that the injury is caused principally by three species—*Psallus seriatus* Reut., *Lygus pratensis* L., and *Adelphocoris rapidus* Say.

Investigations to determine why cotton squares are blasted by the attack of these insects have been continued. These fail to indicate the presence of any disease organism transmitted by the insects, but suggest that the injury is caused by some form of toxin, probably of a salivary nature, injected by the bugs in biting.

The time and manner of the movement of these insects from native host plants to cotton and from one field or portion of a field of cotton to another was studied by means of screens, coated with adhesives, set in and around cotton fields; by sweeping areas with nets; and by collections made by airplane. The collection by airplane of considerable numbers of the cotton flea hopper at various altitudes up to 1,000 feet is noteworthy, as is also the recovery of the wingless nymphs at altitudes of 200 and 500 feet.

PINK BOLLWORM

Research on the pink bollworm conducted in Texas was continued in cooperation with the Texas Agricultural Experiment Station. Investigations were also carried on in the Laguna district of Mexico.

Studies to determine the possibility of controlling the pink bollworm by cultural practices have been continued in the Big Bend area at Presidio, Tex., with the additional cooperation of the Division of Agricultural Engineering of the Bureau of Public Roads. Results of the experiments carried on during the year emphasize and confirm the observations reported last year.

Investigations of possible host plants of the pink bollworm, especially wild plants, were conducted in western Texas and Mexico. Experiments at Tlahualilo, Mexico, proved that *Hibiscus cardiphyllus* A. Gray, a wild plant which grows commonly in the canyon, can be infested with pink bollworm moths reared from cotton. It has also been found that the pink bollworm can survive the winter in seed capsules of this plant and reinfest it the following year.

Studies of the flight and migration habits of the pink bollworm have been continued. Observations made at Tlahualilo, Mexico, show that the flight of moths in fields of zoca or stubble cotton takes place from May to October, inclusive. The movement of moths from planted cotton occurs chiefly in August. The greater number of the females caught on the migration screens were found to contain well-developed eggs. The May flight in the zoca cotton has a distinct relationship to infestation of planted cotton. In the Big Bend area of Texas flight of the moths occurred only from the middle of September to early November and was insignificant as compared with the movement observed at Tlahualilo.

Larvæ hatching from eggs laid in cotton bolls have, in the Big Bend area at Presidio, a minimum feeding period of nine days with an average of 12.8. In other parts of the area where observations were carried on the average feeding period within the boll was 15 days. In none of the experiments did larvæ enter the overwintering or so-called long-cycle stage when the temperature averaged 77° F. or above. Below this temperature from 17 to 68 per cent of the larvæ entered the long-cycle hibernation stage. This emphasizes the importance of removing all volunteer plants from areas in which noncotton zones have been established and is an aid in determining the date of first appearance of the overwintering phases of the larvæ in the fall—a fact of importance in situations where volunteer cotton is growing in alfalfa fields from which hay may be cut and shipped.

Laboratory tests were carried out to determine the effect of moisture content of the soil on the hibernation of the pink bollworm. It was found that soils practically devoid of moisture or those containing

more than 22 per cent of moisture were decidedly unfavorable to the insects. In sandy soils the most favorable moisture content for the hibernation of the insects appeared to lie between 6 and 17 per cent, and in adobe soil the optimum moisture content was about 10 per cent.

BOLLWORM

On account of the heavy losses due to the bollworm, also known as the corn earworm, in certain sections of Texas, and a lack of specific information on the best methods of controlling this pest, special emphasis has been placed on the experimental work carried out in cooperation with the Texas Agricultural Experiment Station. The fact that the losses were found to be intensified by the presence of a number of other cotton pests made it necessary to broaden the investigations and give careful consideration to the interrelation of these insects, and the possibility of developing methods of repression which would successfully cope with several of them simultaneously. The sporadic occurrence of the bollworm also indicated the need of studying the various factors which influence bollworm infestation. Special attention was given to the significance of the proximity of cornfields to cottonfields. Under the conditions prevailing during the last growing season no close correlation was found between the degree of cotton infestation and the proximity to cornfields, although none of the cotton areas studied were more than 300 yards from corn plantings. These studies indicate that the bollworm moths are attracted to rapidly growing succulent cotton and that such cotton should be given special attention in control operations.

Striking demonstrations of the efficiency of calcium arsenate dust in bollworm control were obtained from six experimental plats. Three of these plats received 10 applications of the insecticide at 5-day intervals. They yielded at the average rate of 1,135 pounds of seed cotton per acre, while one of the untreated plats produced seed cotton at the average rate of 405 pounds per acre and the other two untreated plats produced no cotton. A series of experiments were conducted to determine the best time for beginning poison applications. These tests demonstrated the importance of beginning dusting while the larvæ of the first generation of the bollworm were still small. To illustrate: The results referred to above may be compared with that from one plat in which the application of poison was deferred until August 9, when injury was noticeable. In this case seed cotton was produced at the rate of 909 pounds per acre. From a treated plat to which poison was not applied until August 13 and the worms of the second generation were somewhat larger, only 302 pounds of seed cotton per acre was obtained.

COTTON LEAF PERFORATOR

The cotton leaf perforator continues to cause damage in the Imperial Valley of California and in southwestern Arizona. Further investigations of the life history and habits of native host plants of this cotton pest were made in the Imperial Valley, and information on its distribution and economic importance was collected in the area to the east. In eastern Arizona, New Mexico, and Texas the insect

is present but has not become economically important. The control experiments indicate that nicotine sulphate used in a dust will kill a high percentage of the adult moths, and encouraging results were secured with combinations of nicotine sulphate and calcium arsenate. By burrowing into the bolls when the cotton plants have been defoliated by leaf worms this insect may become a pest of some importance. Injury of this type was first noted in the Salt River Valley of Arizona in the fall of 1929 and was thought to be caused by different species.

TROPICAL, SUBTROPICAL, AND ORNAMENTAL PLANT INSECTS

The work under this heading has been under the direction of A. C. Baker.

MEDITERRANEAN FRUIT FLY

Investigational work on the Mediterranean fruit fly has been carried out during the year in Florida and Hawaii.

WORK IN FLORIDA

In Florida various lines of investigation initiated in connection with the eradication effort of 1929, and concerning subjects other than those involving studies of the insect itself, were completed.

A series of reports has been submitted, dealing with the fruiting plants of Florida, both cultivated and wild, which might serve as possible hosts of the fly. The State was divided into three botanical zones and an intensive survey was made of these zones, both as to cultivated and as to wild fruits. In the course of these studies an extensive herbarium was built up. These studies included records of the blooming and fruiting periods and of the condition of fruit in relation to the fly at different times of the year. A study was made also of the individual plants in each plant association throughout the State. For example, a review of 48,746 individual plants in the high pine association shows 28 per cent host plants occurring, whereas in 42,821 plants in the low hammock association only 8 per cent of host plants occur. These studies will have special importance should the fruit fly again appear in Florida.

In the course of the fruit-fly campaign a considerable number of native fruit flies (Trypetidae) were found to infest wild and cultivated fruits in Florida. Technical studies of such flies, started during the fruit-fly campaign, have been concluded during the year. These studies cover both the biology and host relationships of the flies and descriptions of the different species. The publication of these results will greatly facilitate future identification of fruit-fly larvæ.

An important series of studies has also been made on harmful or other action of arsenic, copper, and other bait sprays on citrus and other fruit trees. The reports of this work review all the experimental and practical results obtained during the fruit-fly campaign. The harmful reaction of arsenical sprays has been confirmed, but no harmful reaction on fruit or foliage has been determined as following spraying with copper carbonate.

WORK IN HAWAII

Coincident with the practical elimination of the fruit fly in Florida, all work involving the insect was transferred to Hawaii, together with a considerable number of the personnel formerly engaged in such work in Florida. The University of Hawaii took a keen interest in this new development and offered active cooperation, which was accepted. This resulted in the building on the university grounds of a laboratory equipped with an engine room, cold-storage rooms, constant-temperature room, sterilization room, offices, and laboratory quarters, in accordance with the designs furnished to cover the special type of investigation to be undertaken. In addition, 2 acres of ground were provided for experimental plantings. This laboratory is now under lease to the Department of Agriculture. Pending its building and equipment, the territorial board of agriculture kindly placed its new entomological laboratory at the disposal of the staff without cost.

A rather wide range of useful information on the fruit fly has been accumulated during the year.

High mortality of the fly under high temperatures has been indicated by a series of preliminary experiments. In this work different fruits were used in determining the difference in the resistance of the larvæ on different hosts. Temperatures ranging from 107° to 123° F. were used in the case of the kamani nut. It was found that a considerably longer period was required to obtain 100 per cent mortality with kamani nuts than with citrus and certain other fruits. Seven hours' exposure at 116° was required. Between 117° and 123° almost uniform 100 per cent mortality was evident in one hour. At 109° 24 hours was required and at 107°, 40 hours. This was in striking contrast to the series of experiments with loquats, in which 100 per cent mortality was obtained in seven hours at 109°. These preliminary experiments at least indicate the necessity of testing the temperature resistance with each important fruit or vegetable product.

A series of experiments was carried out to determine the effect of high temperatures on the adult flies. Flies which had been fed for different but definite periods of time after they had emerged, and flies of different origins, were used in these experiments. Under a temperature of 108° F. the range of mortality for exposures between 20 and 80 minutes was from 32 to 88 per cent. Flies of different origins and flies which had had access to different quantities of food also differed in their resistance to heat.

A series of tests was run to determine the effect of high temperatures on pupæ. The series was conducted at 110° F. and involved 11 different time periods. The results, as to percentage of mortality, gave a uniform curve beginning with the 15-minute interval up to 85 minutes, after which 100 per cent mortality appeared in all the experiments.

Experimental work with poison-bait sprays involved a series of tests run at high concentrations to determine the rapidity with which death might be obtained from increased dosage and also the possible repellent effect of the poisons. Other series were conducted in which the concentration ranged from 1 to 24 pounds of poison to 200 gallons of water. Both lead arsenate and copper carbonate were used. Quantities of less than 6 pounds of lead arsenate or 8 pounds of cop-

per carbonate hastened mortality very little. Other experiments with copper carbonate in which the quantity of sugar or sirup was varied indicated that such variation was not so important in copper mixtures as in some other poisons.

The quantity of poison required to kill flies of different ages was studied. Considerable difference in the feeding habits of flies was indicated. Some gorged themselves and others ate more sparingly, and the availability of other sources of food was necessarily an important factor. In these experiments the flies were fed a measured amount of poisoned food only once, the remainder of their food being normal. The results indicated distinct differences in the resistance of different adults and, further, that some individuals would consume the whole quantity of poisoned food while others apparently in the same condition would eat only a portion of it. Moreover, the flies would not consume a given portion of copper poison so readily as they would an equal quantity of lead arsenate. In this connection it is significant that a small quantity of copper carbonate apparently gives no mortality, whereas an equally small quantity of lead arsenate eventually results in the death of the fly. The work in Florida indicated mortality from low concentrations of copper carbonate, but in those experiments the fly had continuous access to the poisoned food as against only one feeding in the experiments here reported.

Various miscellaneous subjects were included in the work done in Hawaii, a detailed description of which is not possible in this report. Such experimentation covered the following subjects:

The influence of size of cages on oviposition. The results indicated that flies oviposited most abundantly in the smallest cages and least in the largest cages, possibly because of the closer juxtaposition of female and fruit in the former.

The relation of temperature, humidity, and period of day to occurrence and activity of adult flies. This work indicated that the most favorable temperature lies between 80° and 82° F. Relative humidity apparently exerted very little influence, but there was an increase of activity with the approach of noon, and a corresponding decrease after midday. A distinct preference was shown by the flies in Hawaii at 82° for the sunny or south side of the tree, whereas previous observations in Florida had indicated preference for the northern or shady side of the tree, probably because of the higher temperatures which occurred in Florida at the time of the observations there. This explanation is further indicated by the fact that flies in Hawaii also showed a preference for the northern or shady side of the tree when the temperature rose above 82°.

The effect of exposure of pupæ to full light. Under such exposure transformation was hastened. This is probably because of the increased temperature over the normal soil habitat rather than because of light.

The morphological characters of larvæ. Considerable differences in these features were indicated in larvæ obtained from different hosts.

The possibility of survival of the Mediterranean fruit fly on food other than fruit. These experiments indicated that flies would remain alive for more than two months on such food as they obtained on the surface of the foliage of different plants (grapefruit, mango, orange, etc.). In some of these experiments the flies had no moisture for a period of 20 days other than that which they obtained from the surface of the leaves. As a check on these experiments, flies kept in cages with the branches only of the trees (all foliage removed) died by the end of the second day, the usual starvation period. Earlier work in Mexico indicates that the food element in such survival is various wild yeasts, although a careful examination of the foliage in the Hawaiian experiments failed to indicate the presence of such yeasts in any quantity.

The percentage of infestation in different fruits and at different periods throughout the season. Striking differences were found in the degree of

infestation in oranges. For example, the Valencia gave only 0.8 pupa per sample as contrasted with 107.6 pupæ for the sour orange, and 3 for the Washington Navel orange.

The relation of ants to larval mortality. The results indicated rather high mortality where ants had access to the cages containing the larvæ which had entered the soil for pupation.

A shipment of three important Mediterranean fruit fly parasites to Spain in response to the request coming through the Spanish Embassy in Washington. This shipment reached Spain successfully and the breeding of a new stock there is now reported to be well started.

The record of parasite rearings which has been maintained by this bureau in cooperation with plant-quarantine work for a series of years. There was started this year an additional series to determine the actual percentage of infestation of fruits. This has involved some 33 fruits, and the results will indicate also the relative infestation of these fruits under Hawaiian conditions. Studies are being made, also, of the relative infestation of different varieties of the same fruit—as, for example, mangoes—where a very considerable difference of this sort is known to occur.

Relative infestation of bright and russet fruit. During the fruit-fly campaign in Florida it was observed that bright fruit was much more heavily infested than russet fruit. This preference has been confirmed by experimentation conducted in Hawaii during the year. An investigation of the rate of development of the fly in different species of fruit indicated that avocados give the most rapid, and apples the most retarded, development.

The hot-vapor system of fruit disinfection. This system, developed in Florida, has been applied in an experimental way to pineapples in Hawaii, with results indicating that it can be used with this fruit.

MEXICAN FRUIT FLY

Work at the laboratory established in Mexico City for study of the so-called Mexican fruit fly and of other related species has produced much new and useful information contained in a number of preliminary reports. These have covered (1) a cytological study of some of the more important fruit flies occurring in Mexico; (2) a study of *Opinus crawfordi* Viereck, the most abundant parasite of the Mexican fruit fly; (3) investigation of the effects of temperature on the adults, pupæ, and larvæ of the Mexican fruit fly; and (4) toxicity studies in search of a satisfactory bait spray, the studies concerning chiefly arsenical and copper compounds, and indicating a marked difference of reaction between the Mediterranean species and the Mexican fruit fly.

MISCELLANEOUS

The work on fruit flies and other subtropical pests in the Canal Zone, now long standing, has concerned several species of fruit flies, some of which have not hitherto been recorded, or, if so, have been confused with other species. Several of these species occur abundantly in certain native fruits and are therefore of potential importance to cultivated fruits. Biological studies of several of these flies have been made.

The important cooperative project with the Cuban Department of Agriculture looking to the control of the black fly by importing its natural enemies from Asia was mentioned in the report of the bureau for 1930. This work, which covered two years, has been brought to a very successful conclusion during the current year. Several different types of parasites and predacious enemies of the black fly have been introduced and one of the parasites, *Eretmocerus serius* Silv.,

has multiplied to such an extent that it has been possible to make liberations throughout Cuba and also to establish colonies in the Canal Zone and in Hawaii. At present this parasite is quite generally distributed in all Provinces in Cuba, and all groves in which colonies were established prior to October, 1930, are now rated as commercially free from the fly. In addition to this parasite, a number of coccinellid beetles were introduced and one of these has demonstrated ability to do effective work.

The laboratory established at Whittier, Calif., in cooperation with citrus growers, is now fully equipped and important work has been in progress there during the past season. A considerable series of studies dealing with the resistance of the red scale to hydrocyanic acid gas fumigation—the primary purpose of the establishment of the laboratory—has been instituted. The Bureau of Chemistry and Soils is cooperating in this project through a chemist detailed to the laboratory to participate in all the chemical phases of the work. Important biological studies of the citrophilus mealybug and the red scale, including determination of the optimum temperature conditions, were also conducted at the laboratory. The results of these studies, while promising, are not ready to be made the subject of a definite report at this time. Other work in California has been the continuation of the study of thrips injury to citrus in the San Joaquin Valley and also in other parts of the State and adjoining States. This study has increased and confirmed the efficiency of control by the proper application of sulphur dust.

Studies of the insect enemies of the date palm in California, Arizona, and Texas, now centered at the laboratory at Whittier, have covered technical studies of the insect, resulting in a monographic report on its structure and anatomy, and also a continuation of experimental work on the control by high temperatures of the palm scales in date offshoots.

At the New Orleans laboratory special study on the camphor scale and the palm scale has been continued, the chemical phases of control measures being carried out through the cooperation of chemists assigned from the Bureau of Chemistry and Soils. Technical studies on the biology of both scale insects have been completed for several years. The palm scale has been steadily increasing in New Orleans, where it is a pest not only of palms but also of citrus and other plants. It recently has been reported as a pest of avocados in California. The study of natural control by parasites has indicated the inadequacy of such control, but on the other hand artificial control is easily possible, 100 per cent mortality having been obtained with an oil emulsion, using from 1 to 1.3 per cent of oil. In connection with studies of oil emulsions, carried out in cooperation with the representative of the Bureau of Chemistry and Soils, the factors influencing natural mortality have been determined so that an accurate estimate of the direct effect of the oil sprays can be made.

BULB AND GREENHOUSE INSECTS

Continued effort has been made to obtain improved or more efficient methods of destroying, by disinfection, any infestation in bulbs by bulb flies. Its purposes have been to prevent losses in the

field from the use of infested planting stock and to meet conditions imposed by the bulb-quarantine regulations on interstate transportation of bulbs. This work has been carried out in cooperation with a representative detailed from the Bureau of Chemistry and Soils and has involved fumigation with both calcium cyanide and sodium cyanide. Sodium cyanide has proved to be equally as effective as calcium cyanide and has now been authorized by the Plant Quarantine and Control Administration as an alternative for the fumigation of infested bulbs. Tests this year have substantiated earlier results, which indicated that difficulties in the fumigation of bulbs are almost entirely due to conditions of moisture in the bulbs themselves, frequently associated with certain bulb-rot organisms, making it impossible for the poison to penetrate to the larvæ. If, on the other hand, such bulbs are broken or cracked, allowing access of the gas, 100 per cent killing of bulb-fly larvæ results. No injurious effects on the bulbs were observed either in forcing or in bulb growth except where very high concentration and long exposures were employed.

The possibility of using vapor heat for killing bulb-fly maggots in bulbs was taken up last year. The idea originated as an offshoot of the disinfection of fruit for the Mediterranean fruit fly. During the current year some 19 experimental runs were conducted at Sumner, Wash., involving a total of 168 tons of planting stock and representing many of the leading commercial varieties of bulbs. While the complete data on the effect on the bulbs so treated will not be available until after the crops are harvested, cured, and weighed, the indications are very promising. The earliest lots so harvested show a substantial increase in weight over the untreated checks. The treatment consisted of holding the bulbs for four hours at a temperature of 110° F. While some injury was noted on certain lots treated at temperatures higher than 110°, no complete loss resulted. The effect in reducing field infestation of flies and nematodes was satisfactory. Similar tests were conducted at Babylon, N. Y., but here the results were less satisfactory. In this instance, again, complete records of the harvested crop are not available.

One of the new activities undertaken this year is the study of the cyclamen mite, which has been causing very heavy losses to growers of that plant. It develops, from studies made, that two different types of mites are concerned, which may occur either together or separately. These mites have also been found to attack other hosts than cyclamen. Preliminary experiments indicate the possibilities of control for these enemies by the use of hot water at a temperature between 110° and 112° F. for 15 minutes. The use of water at a temperature of 115° for 5 minutes also gave complete clean-up without injury to the plants used, 5 minutes at the lower temperatures having proved unsatisfactory. Other and perhaps simpler methods of control are being studied.

In connection with the field control of bulb flies, deep planting has been frequently recommended as a means of preventing infestation. To give experimental basis for this belief, experiments were laid down in the fall of 1929, in which six varieties of narcissus bulbs—Emperor, Spring Glory, Glory of Sassenheim, Victoria, King Alfred, and Tresserve—were planted at depths of 5, 7, and 9 inches,

respectively. These tests indicated that the lesser bulb-fly infestation was noticeably lower in the bulbs planted at the 9-inch depth, the growth and flower formation being slower and quite irregular.

A thrips, *Liothrips vaneeckei* Priesn., was brought to the attention of the bureau last January by the horticultural commissioner of Oregon, and was reported from several localities as being quite injurious to lily bulbs. This appears to be an imported species and naturally is causing concern to Oregon growers interested in the commercial production of lilies. A survey has been undertaken in the lily-growing district of Oregon to determine the distribution and actual economic status of this new pest.

INSECTS AFFECTING FOREST AND SHADE TREES, INCLUDING THE GIPSY MOTH AND THE BROWN-TAIL MOTH

The work in this field is under the direction of F. C. Craighead.

COOPERATIVE OR SERVICE WORK

The cooperative work of the division of forest insects required by far the largest part of its activities. It consisted in giving technical advice on insect control (chiefly of pine bark beetles) to the various agencies administering public lands. Large tracts of timber were surveyed, the amount of bark-beetle infestation estimated, and recommendations made for control. Technical direction and aid were given also at the time the other agencies were conducting the actual control work. Some of the more important projects conducted by the Forest Service and National Park Service under the technical direction of the Bureau of Entomology are described in the following paragraphs.

The largest project in control of bark beetles undertaken thus far was attempted in the Coeur d'Alene National Forest in the spring of 1930. A total of 600 men were employed and \$135,000 was spent in combating an outbreak of the mountain pine beetle (*Dendroctonus monticolae* Hopk.) in the white pine stands of that forest, and as a result a reduction of 67 per cent in losses of the following year was obtained. An allotment of \$50,000 was made for treating the remaining infestation during the spring of 1931.

Control measures against an outbreak of this insect in the white pine stands of the Kootenai National Forest were also directed. Following an expenditure of some \$14,000, a reduction of 80 per cent in the 1930 infestation was secured. Other work was done in combating outbreaks of the mountain pine beetle in small areas of white pine in the Clearwater National Forest and Glacier National Park. A reduction of more than 90 per cent of the infestations was secured.

The effort to control the mountain pine beetle within the lodge-pole pine stands of the Targhee, Teton, Wyoming, and Caribou National Forests was continued during the 1930 season, and approximately 72,000 trees were treated at a cost of \$65,000. While the results have not been entirely satisfactory, the outbreak has been held in check and reductions in the infestation ranging from 55 to 65 per cent have been secured. This work is being continued during the present season and every effort is being made to treat as nearly 100 per cent of the infestation as possible. It is only by means of a thor-

ough clean-up of these forests that it can be determined whether reinfestation is coming from heavy centers 30 to 50 miles distant. The seriousness of this infestation lies in the fact that these forests are adjacent to the Yellowstone National Park and, if this outbreak is allowed to develop, there is no doubt that the scenic lodgepole pine forests of that region are doomed. During the 1930 season small groups of new infestations were discovered within the Madison National Forest, which borders the Yellowstone Park to the north, and within the park boundary itself. The Madison infestation apparently originated from the Beaverhead National Forest, where there has been an infestation of such magnitude that control measures are not feasible.

Work against the mountain pine beetle was supervised in the Crater Lake and Mount Rainier National Parks. In Crater Lake National Park approximately 10,000 infested lodgepole pine trees were treated by the solar-heat method, and very good results—75 per cent reductions in infestation—were secured. In Mount Rainier National Park several small outbreaks in white pine stands were subjected to the burning and peeling methods, and it is believed that this infestation can be entirely eliminated.

Control work to reduce infestations of the western pine beetle was recommended and supervised in Oregon and California. In southern Oregon the control of this beetle occupied the attention of the private timber owners, the Forest Service, and the Bureau of Indian Affairs. Approximately \$50,000 was spent in this work during the year and fairly satisfactory results in reducing the losses were obtained. Continued subnormal rainfall lowers the resistance of the pine trees and renders them more susceptible to attack. Through the control work it is hoped to keep the beetle population at a minimum until moisture conditions are again normal.

Because of the high value of the forest cover on recreational areas, active interest has been manifested in the protection of coniferous trees from destructive insects. This interest is shown particularly by owners of mountain homes, resorts, municipal and county playgrounds, etc., in southern California and in the Sierra Nevada region. Control of forest pests is equally important on public camp grounds maintained by the Forest Service and on areas leased for recreational uses within the national forests. Such work has been conducted in three such areas in southern California through the cooperative efforts of private organizations, the Forest Service, the State forester, and the Bureau of Entomology. These projects cover a relatively small area, but on account of the high values which forest cover imparts to the land are considered to be a profitable activity which should be continued as a community program on an annual maintenance basis. The Forest Service has recently included in its leases for summer-home lots a clause requiring an annual inspection and removal of infested trees on such properties.

RESEARCH WORK

The research work of the Division of Forest Insects to develop more economical and effective methods of combating outbreaks of forest pests has been very much curtailed by the necessity of conducting the cooperative and service work already discussed. The

more important of the investigational studies of the year may, however, be noted.

In connection with the work against the mountain pine beetle an intensive study of insects found in association with this destructive forest pest has been made. It is to serve as a basis for protecting and favoring the beneficial parasites and predators in connection with the application of artificial control measures. With this object in view, small-scale tests of various control measures have been carried out, some of which show promise of being worthy of further consideration.

Studies of the western pine beetle in the Modoc National Forest were continued. A series of samples representing the inner-bark conditions of infested and living trees were collected and analyzed in the laboratory at Berkeley, Calif. The results confirm those obtained in previous work, and indicate that chemical changes in the reducing sugars of the inner bark render the tree attractive to the beetles and very largely control the successful development of the larvæ. A preliminary study of the acidity of the phloem of western yellow pine indicates that the pH values may be applied in determining the susceptibility of the tree to beetle attack. This study, together with that on the sugar determination of the inner bark, has been conducted with the object of defining the nutritional requirements of the western pine beetle. A determination of these conditions in the felled tree—i. e., whether favorable or unfavorable to brood development—can be applied directly to methods of slash disposal, so as to prevent the breeding-up, in such material, of bark-beetle infestations. The California State Board of Forestry cooperated in this study by carrying the salary of an assistant for four and one-half months, and laboratory facilities have been furnished by the University of California.

Further experimental work was done to test methods of control which will protect the clerid predator of the western pine beetle and at the same time will destroy a high percentage of the beetle larvæ. It was found that the method developed the preceding year, which consists of felling trees infested by the summer brood and exposing the unpeeled logs to solar heat, was effective. This method can be applied only during the summer period, however, and should be given a thorough trial on an experimental project before it can be recommended for general use.

FOREST DEFOLIATORS

Spraying to determine the effectiveness of lead arsenate as a means of combating outbreaks of the spruce bud worm on Douglas fir was conducted within the Cody Canyon, Shoshone National Forest, during the 1930 season. The insect proved difficult to destroy with a stomach poison, because adequate coverage of the new foliage is hard to secure and because of the habit which the larvæ have of feeding concealed at the base of the new needles.

A colony of *Calosoma sycophanta* was obtained from the gipsy moth laboratory, Melrose Highlands, Mass., and liberated at Northport, Wash., where an epidemic of the Douglas fir tussock moth existed. It is hoped that this beetle enemy of the tussock moth

will become established in this region, and that it will prove to be a factor in the control of this and other defoliating insects.

A very serious outbreak of the hemlock looper was discovered late in the fall of 1930 on private lands in Pacific County, western Washington. An area of approximately 5,000 acres of hemlock forest was found to be infested. The only known method of control is by dusting the trees with arsenicals liberated from an airplane. The owners of the timber adopted plans for carrying out a project under the general supervision of the bureau's entomologists.

The Sitka spruce forests along the coast of Oregon and Washington show a very unhealthy and dying condition, caused largely by insect attack. The green spruce aphid has been found to be partly responsible for this condition in the tidewater belt. A study of causes and remedies is now under way.

PINE BEETLES IN THE SOUTHEAST

Additional data secured during 1930 support previous conclusions that outbreaks of the southern pine beetle are correlated with marked deficiencies in rainfall. During 1930 there was a deficiency in precipitation for every month of the year except September and November in the mountainous sections of western North Carolina and eastern Tennessee. In the vicinity of Asheville this amounted to 15.81 inches, and for the region in general from 6.66 to 13.97 inches for the 12-month period. During this time outbreaks of the southern pine beetle were reported from many localities in this area, and it is believed that timber losses in 1930, due to this pest, reached the high point of the past 20-year period.

WHITE-PINE WEEVIL

The records which are made yearly on the permanent sample plots in the New York-New England area showed that infestation by the white-pine weevil over the region as a whole did not increase in 1930 over 1929. In most localities there was a decrease. This may be explained, partially at least, by the fact that the preceding winter was mild and the snowfall was below normal, so that hibernating conditions were not good. The actual damage, however, was more severe than in the previous year because the percentage of leaders killed back three or more years was greater than previously noted. Drought may have contributed to this condition, the possible deficiency of moisture in the upper part of the tree forcing the larvæ to work farther down the stem in order to obtain an adequate quantity of food.

BRONZE BIRCH BORER

Considerable time was devoted to completing the studies on the decadence of birch in northern New England. These studies have shown that no one factor is responsible for the death of the trees. Insects, fungi, and physical factors occurring after the opening of the stand are important. A report of results of this work is now in manuscript form.

INSECTS AFFECTING FOREST PRODUCTS

A large number of additional wood preservatives have been under test in Panama in cooperation with the Forest Products Laboratory of the Forest Service. These long-time tests of woods treated with preservatives, as well as of wood-pulp and fiber products treated with poisons, are intended to determine protection from attack by termites, and were begun at Falls Church, Va., in 1911, and reestablished in the Canal Zone, Panama, in 1924. International cooperative work in testing wood preservatives against termites was undertaken in 1929 by the Forest Products Laboratory and this bureau. The second annual report of such cooperative work, submitted by the officials of South Africa, Australia, Hawaii, and Panama, indicated in general that these preservatives have behaved in much the same manner in these several countries and with different kinds of termites. In other words, there has been little difference in these countries as to benefits or the lack of such benefits from the different preservatives used. Other governments (Mexico, India, and Malaya) have requested that these tests be enlarged to include their countries, but owing to insufficient funds this is not possible.

The termite-proof test buildings, bridges, and tower constructed in Panama of treated timber or of termite-resistant woods, through cooperation with the American Wood Preservers Association, continue to be uninjured by termites. Two new buildings constructed of treated timber were added to these tests in 1931; the dimensions of these buildings are approximately 18 by 18 by 10 feet. Progress is being made in securing the inclusion in mandatory city building codes of the suggestions of the Bureau of Entomology for prevention of termite damage. City chambers of commerce are actively cooperating with the Bureau of Entomology in efforts to prevent termite damage to buildings. Cooperation is also being continued with the National Committee on Wood Utilization in advocating the retail sale of treated timber and its greater use in the construction of buildings.

A biological experiment of interest has been the breeding of long-winged and short-winged reproductive adults of *Reticulitermes flavipes* Kol. and the crossing of these forms to determine the origin of the castes and to solve other problems of evolution. Young termites are being secured from such crosses for the first time.

The collection of the termites of the world in the United States National Museum has been greatly enlarged during the year and is now the second largest collection in the world. It contains 795 named species, including 565 types, and much unnamed material. The catalogue and index with supplementary bibliography of the termites of the world has been brought up to date. Such a collection is invaluable in naming termites from all parts of the world.

SHADE-TREE INSECTS

The drought of last year has increased damage by shade-tree and hardy-shrub insects over much of the eastern part of the United States, as indicated by the greater demand, through correspondence and other requests, for information in this field. This year, at the request of the War Department, examinations and reports on damage of this sort in a number of the national cemeteries were made.

During the past season, the dying of the Monterey and the Italian cypress trees has presented a serious problem in southern California, where these trees are planted extensively as windbreaks and also as shade and ornamental trees. An investigation by the Division of Forest Insects indicated that the damage was caused in large part by the cypress bark beetle, but with defoliating insects and a plant disease contributing. The importance of these trees seems to warrant a thorough study of these difficulties with the object of developing methods of control.

This year, as in former years, the small appropriation available for work on insect enemies of shade and ornamental trees prevented any adequate research and experimental work in the general field. When the homes and estates, public parks, and city plantings are taken into consideration, it would seem that this is a field well worthy of expansion. With present funds it amounts largely to a correspondence project, the experimental work being negligible. During the year, however, some taxonomic work has been done, resulting in the publication of two technical papers on diprionid sawflies. A considerable number of identifications of materials submitted by correspondents have been made. A number of radio talks on insect pests of ornamentals have also been given.

GIPSY MOTH AND BROWN-TAIL MOTH

FOREIGN WORK

Field investigations have been carried on by two entomologists in Hungary, Yugoslavia, and Austria from headquarters at Budapest. Biological studies of certain insect enemies of the gipsy moth, brown-tail moth, and satin moth have been conducted, and about 185,000 parasites have been sent from these countries to the gipsy moth laboratory at Melrose Highlands, Mass. Over one-half of this material consisted of puparia of a tachinid fly, *Phorocera agilis* R. D., which is parasitic on the gipsy moth, while approximately 35,000 puparia of *Tachina larvarum* L., another tachinid parasite of the gipsy moth, and 16,000 puparia of a third tachinid, *Carcelia gnava* Meig., parasitic on the satin moth, were included. About 4,000 cocoons and adults of hymenopterous parasites were forwarded. The remainder of the material consisted of puparia of several species of tachinid flies. After considerable search, a small, light infestation of *Phyllotoma nemorata* Fall. was found at Weitersfelden, Austria, and small shipments of its hymenopterous parasites were sent to the gipsy moth laboratory. *Phyllotoma nemorata* is a sawfly which mines the leaves of birch. It gained entry into Maine and has spread into New Hampshire and Massachusetts, and it is hoped that it will be possible to establish some of its European parasites in these States.

Approximately 779,000 cocoons of the oriental hag moth (*Cnidocampa flavescens* Walk.) were sent from Japan to the gipsy moth laboratory in 1930, in order to secure a tachinid parasite, *Chaetexorista javana* B. and B., for liberation in the vicinity of Boston, Mass. Arrangements for collecting and shipping these cocoons were made by an entomologist of this bureau, engaged in Japanese beetle

investigations in Japan, who also made arrangements by which two shipments of gipsy-moth material, infected with a fungus, were sent to the laboratory from that country.

PARASITES AND PREDATORS IN NEW ENGLAND

Sample collections of the eggs, larvæ, and pupæ of the gipsy moth were made as usual in the infested New England area during the year. They indicated that one of the egg parasites, *Anastatus disparis* Ruschka, was about as important as in the previous year, while the other egg parasite, *Ooencyrtus kuvanae* Howard, showed a slight decrease. Of the parasites attacking the larvæ, *Apanteles melanoscelus* Ratz. and *Compsilura concinnata* Meig. showed an increase, while *Sturmia scutellata* R. D. remained about as efficient as before. Field observations indicated that the beetle *Calosoma sycophanta* L. destroyed a greater proportion of larvæ and pupæ than in 1929.

Dissection of brown-tail moth caterpillars from sample winter webs showed that there was a slight increase in parasitism, but there was a decrease in parasitism in the summer collections of large larvæ.

During the year approximately 50,000 adults of parasites received from Europe were liberated in New England. Of these 1,300 were mated female adults of the tachinid *Phorocera agilis* R. D., and in addition 10,000 gipsy-moth caterpillars bearing eggs of this parasite were put out. The fly was again recovered in small numbers from one locality where it was colonized in 1927 and 1928. Over 26,000 adults of *Tachina larvarum* were liberated, as well as several thousand adults of the gipsy moth's other tachinid and hymenopterous parasites. Some 9,000 adults of *Carcelia gnava* and about 2,000 adults of a species of *Meteorus*, both parasitic on the satin moth, were put out. Dissections of satin-moth larvæ made later indicated that the *Meteorus* had established itself, and during the year it was found that another recently established satin-moth parasite, *Apanteles solitarius* Ratz., had spread considerably.

Over 80,000 adults of *Chaetoxorista javana* which issued from cocoons of the oriental hag moth received from Japan were released in Boston, Mass., and vicinity. Indications are that this tachinid has established itself as a result of liberations made in 1929 and 1930.

One thousand five hundred adults of *Calosoma sycophanta*, a predacious beetle introduced into New England from Europe a number of years ago, were collected by means of traps recently devised at the gipsy moth laboratory and were sent to the State of Washington. It is hoped that the beetle will become established there, especially as an enemy of the satin moth and the fir tussock moth (*Hemerocampa pseudotsugata* McD.). Over 2,000 puparia of the tachinid *Compsilura concinnata*, another long-established enemy of the gipsy moth, were also sent to the State of Washington in order that the fly might be liberated in infestations of the satin moth there, and 1,400 puparia were forwarded to the Canadian Dominion parasite laboratory to be used for the same purpose in British Columbia. Approximately 300,000 adults of the egg parasite *Anastatus disparis* of the gipsy moth were colonized in Maine and about 9,000 adults of *Calosoma sycophanta* were put out at various points in New England.

BACTERIAL AND FUNGOUS DISEASES

Attempts were again made to isolate pathogenic bacteria from gipsy-moth larvæ that died in rearing trays at the laboratory. About 50 cultures were recovered and 21 of these were used in inoculation experiments. Only one proved strikingly pathogenic and an attempt is being made to hold this form on artificial media for experiments in the summer of 1931. Several cultures recovered in 1929 were kept until 1930 and tested. Only one showed even slight pathogenicity, but virulence of the cultures may have been reduced by holding them on artificial media.

Results of an attempt to determine what is responsible for the death of certain satin-moth larvæ are inconclusive, but suggest that the larvæ may be affected by a condition similar to that producing "wilt" of gipsy-moth larvæ.

The brown-tail moth fungus (*Entomophthoraaulicæ* Reiche) was especially abundant in New England in the summer of 1930. Field experiments were conducted in which trees infested with satin-moth larvæ were dusted with spores of *Beauveria globulifera* Speg. and *Isaria* sp., but the results, in contrast with those obtained the previous year, were disappointing. It is as yet too early to give any information regarding results obtained from the shipments of the Japanese gipsy-moth fungus-disease material received during the year.

ATTRACTANTS

The principal conclusions to be drawn from the year's attraction experiments with the gipsy moth are as follows: Toluene, xylene, benzene, and certain gasolines were the best solvents for the preservation of female genitalia which were later exposed in the field to attract males; kieselguhr, sodium carbonate, and wool gave promise as absorbents for exposing the attractant in the field; females contained very little of the attractant when freshly emerged and the maximum amount was available two to four days later. Attempts were made to increase the percentage of emergence of moths from collected pupæ, and a simple method of sealing and preventing evaporation of the solvents in storage was devised. A manuscript covering the work that has been done on attractants at the laboratory was prepared for publication.

INSECTICIDES

Six woodland areas infested with the gipsy moth were sprayed with barium fluosilicate, cryolite, and lead arsenate. Each material was used at the rate of 4 and 5 pounds to 100 gallons of water, with 4 ounces of fish oil added to each pound of poison as a sticker. Better control was noted where lead arsenate was used. Cryolite seemed quite promising, though it did not adhere to the foliage satisfactorily.

Spraying experiments to prevent injury to the small fruit of peach showed that good control can be obtained by timely spraying with 3 pounds of lead arsenate, 3 pounds of hydrated lime, and 12 ounces of fish oil to 100 gallons of water. Experiments have been

begun to ascertain whether certain lepidopterous spruce leaf miners, especially *Epinotia nanana* Treitschke, can be satisfactorily controlled with arsenical sprays.

In tests with substances that might increase the adherence of poison dusts, talc, ferric oxide, casein glue, lampblack, bentonite, and calcium carbonate gave the best results. In connection with experiments with poison dusts, attention was given to the possibility of developing a method by which a cartridge containing the dust can be shot from a modified grenade discharger in such a way that the poison will be satisfactorily applied to the foliage of trees. It is as yet too early to give an opinion regarding the practicability of this method of application.

Various insecticides were used to ascertain to what extent they were toxic to gipsy-moth caterpillars. These tests were conducted in the laboratory, the caterpillars being confined in trays and given sprigs of foliage treated with the different poisons. With the lethal dose as a standard, the toxicities of some of the materials were as follows: Lead arsenate, 100; calcium arsenate, 100; arsenic trioxide, 60; magnesium arsenate, 50; cryolite, 45; barium fluosilicate, 35; and sodium fluosilicate, 35.

To secure information on the action of arsenicals on the leaf surface, 18 field plats were treated. Leaf collections were made from these plats before and after various quantities of rain, and these leaves were tested for pH, total arsenic, water-soluble arsenic, and tissue arsenic. As the quantity of arsenical decreased on the foliage throughout the season the percentage of solubility increased, because of the increased ratio of water over arsenical. The breaking down of arsenicals in dew, fog, and rain water on the leaf surface was found to be caused by the buffered acid condition on the leaf, by the action of carbon dioxide in setting free the arsenious acid, and by the presence of salts and impurities. In sprayed plots there was an average of 0.000025 gram of arsenious oxide (tissue arsenic) per 100 square inches beneath the leaf surface, and more in the case of injured tissue. Observations indicated that injury was much greater from the lower surface of the leaf.

During the last two years an air-pressure brush, intended especially for applying creosote to gipsy-moth egg clusters, has been devised at the laboratory. Experiments have shown that this brush can be used to advantage when creosote is to be applied to egg clusters in heavy woodland infestations. When compared with the old method of using a separate can of creosote and a brush attached to a bamboo pole, there is a saving of time and, in some cases, of creosote.

STATUS OF MOTHS

Estimates on the abundance of the gipsy moth in New England, made by employees of the Plant Quarantine and Control Administration, indicate that defoliation in 1930, as compared with that in the previous year, was considerably reduced. The acreage showing from 1 to 100 per cent defoliation in 1930 was estimated at 155,542, whereas in 1929 it was placed at 551,133.

Defoliation by the brown-tail moth in 1930 was, as has been true for the past few years, confined for the most part to areas in south-

western Maine, southeastern New Hampshire, and northeastern Massachusetts. The limits of this area were somewhat beyond those of 1929, and a rough survey indicated an increase in the acreage defoliated. Apple-tree foliage furnished the bulk of the food for the caterpillars.

INSECTS AFFECTING STORED PRODUCTS

The investigations of stored-product insects have been conducted, as formerly, under the direction of E. A. Back.

DRIED-FRUIT INSECTS

The fig moth has become a pest of increasing importance in the past several years. Its heavy infestation and widespread occurrence in dried cut fruits, figs, and especially in raisins, necessitated a study of its activities in storage and in the field as a background for control measures. Life-history studies in the laboratory, begun previously, during the year were brought to a point which is considered satisfactory for the present, and the data have been summarized for use.

As a result of cooperation extended to the bureau by the administration of the California raisin pool (organized in furtherance of the grape-control plan of the Federal Farm Board), much valuable information on the fig moth as a pest of dried fruits was obtained through surveys of storage plants storing the greater part of the 1930 raisin crop of about 160,000 tons. Of special value to science and industry were data secured on the control exerted by the parasites *Microbracon hebetor* Say and *Nemeritis canescens* Grav. and the predacious ants *Formica fusca argentata* Whlr. and others, and by high surface-soil temperatures, upon migrating fig-moth larvæ.

On investigation of the drying fields and storage houses on the ranches, fig moths were observed at night in numbers above dried fruits and over trays of drying raisins in vineyards. Infestation developing in samples of raisins taken from trays served to explain the abundance of fig-moth larvæ later developing in storage. Muscat raisins were found infested in the field to the extent of 4,300 per ton and Sultanina (Thompson seedless) to the extent of 6,200 per ton.

Late in February, 1931, examination of vines in 16 vineyards showed an average of 15.4 per cent of the vines sheltering overwintering larvæ of the fig moth under the bark. The larval population in some instances was estimated at 575 per acre. Previous search in soil, under boards, in fig orchards, etc., had revealed few larvæ of the fig moth and had failed to account for the magnitude of the population on ranches and in storage. *Microbracon hebetor* has been the chief parasite enemy of fig-moth larvæ during the year. A study of the life history of this parasite was finished during the year and a manuscript presented for publication. A life-history study of the parasite *Nemeritis canescens* has been begun.

The saw-toothed grain beetle and Indian-meal moth were not abundant during the year. In increasing to large numbers both species depend upon supplies of long-stored, unprotected dried fruits. The carry-over of raisins from the 1929 crop was not large, and figs were well protected in fumigable storage. The saw-toothed grain beetle does not develop on ranches in new-crop fruit, and dur-

ing 1930 the Indian meal moth did not do so to any appreciable extent.

Tests of materials as repellents against the dried-fruit beetle and other Nitidulidae were conducted. Cresylic acid, phenol, and oil of tar gave promise in cage tests and were tried out in a fig orchard on a small scale, with no indication of protection to the crop. Attempts to reduce injury from dried-fruit beetles by the use of traps was continued during 1930. The traps used were of the type devised at the laboratory in 1928, and were baited with slowly fermenting dried peaches. An average catch of 2,451 nitidulid beetles per trap was secured in four widely separated fig plantings. A prediction of small-to-average damage by dried-fruit beetles to the 1931 fig crop seems justified by trapping records.

Experiments with the more promising fumigants have been continued during the year. Tests with sulphur dioxide were very promising in effectiveness, cheapness, safety, and easy applicability. The vapors were developed either by burning powdered sulphur in ordinary ranch sulphuring houses or from liquefied sulphur dioxide from cylinders. Tests made in cooperation with the California Dried Fruit Association showed heavy concentrations effective with exposures of one and one-half to three minutes. For the first time the mixture of ethylene oxide and carbon dioxide snow was used in successfully treating individual 25-pound packages of raisins with a dosage of one-fourth ounce of the mixture per box. This fumigant gives promise of supplanting ethyl formate for individual-pack fumigation.

Experiments conducted in cooperation with the Deglet Noor Date Growers Association at Indio, Calif., have led to the adoption of atmospheric instead of vacuum fumigation for the treatment of the 1930 crop of dates, at a saving of \$3,000. This saving in cost of treatment will be a continuing one.

The unsatisfactory market for dried figs of the 1930 crop resulted in an unusually large quantity of fruit being held in storage. Most of the crop was held in fumigable storage, largely because of past recommendations of the bureau, and this prevented insect damage which otherwise would have been serious. About 168 units of fumigable space (bins, rooms, and separate houses) were available in Fresno and its vicinity for the fumigation of figs and other dried fruits. Four years ago there were about 10 units in the same area.

During the year seven publications have been issued or prepared for publication, the most important dealing with fig insects in California. Reports were read at the Annual Institute of Fig Growers and at the annual meeting of the Dried Fruit Association of California.

PEA WEEVIL

At the request of the field-pea growers of the Northwest, and of the agricultural authorities of the States of Idaho, Washington, and Oregon, Congress appropriated funds for an investigation of the pea weevil as a pest of field peas. This investigation, begun July 1, 1930, has centered during the year at Corvallis, Oreg. The problems receiving special attention have had to do with the percentage of field infestation of the maturing crop, the hibernation of the

weevils between crops, and methods for destroying weevils in the seeds left behind in the field after harvest.

A detailed study of the infestation of crops of field peas indicates that the degree of infestation is influenced greatly by the number of successive years during which the field has been planted to peas. Other factors, such as close proximity to warehouses storing untreated peas and to fields of unharvested garden peas, were found important in this connection, but were not studied carefully. Examinations of harvested crops showed infestations ranging from 1 to 10.5 per cent in fields where only one crop of peas had been produced. In fields planted to peas for two successive years the average infestation was from 22.5 to 27 per cent. In fields planted to peas for three years or more the percentage of infestation ranged from 77 to 91 per cent. These percentages of infestation were obtained only in fields where no remedial measures had been applied.

Previous to the start of these investigations it was supposed that field infestation was brought about by adult weevils living over the winter in untreated peas stored in homes, warehouses, or other storage places. It was not believed that the adults hibernated about the pea fields. An intensive study of the number and infestation of peas left behind in the field following the different methods of harvesting and threshing brought out the practical information that from 500,000 to 3,000,000 peas per acre may be shattered and left behind on the ground. From exact counts made of all seeds found on certain areas it was estimated that in some fields the seeds left behind on the ground contained from 1,500 to more than 1,000,000 weevils per acre. It was estimated that on one 40-acre field about 47,000,000 weevils were left behind in the fallen seeds and the refuse from the threshing machines.

It had been thought that weevils thus left in the fields could not survive the winter and were not important as factors in establishing infestations in the crop of the following year. While this is possibly true in more severe climates and where the flora of the region is different, it was found that in the mild climate of the Willamette Valley in Oregon, where the foregoing studies were made, the pea weevil adults hibernate in large numbers beneath the bark scales, and in the large quantities of moss (*Usnea plicata*) which develop abundantly on the oaks about many pea fields. Examinations revealed many living adult pea weevils in the moss after the seed for the new crop had been planted.

It is evident that the present practice of fumigating only the cleaned peas in storage kills but a small number of the weevils produced in the crop, whereas the large number of weevils left in the screenings on the ground are liberated to infest the next year's crop. In seeking a method whereby the weevils in the seeds left on the ground can be killed and prevented from entering hibernating quarters, the fact was developed that the warmth of the sun causes the insects in the shattered seeds to develop to maturity and leave the seeds more rapidly than is the case with weevils in seeds sacked and carried into storage. Thus in one instance in the Willamette Valley it was found by September 17, 1930, that 339 weevils had emerged while only 22 remained in the seeds. This early emergence makes it necessary to apply control measures directly against the weevils in fallen infested seeds immediately after harvest.

Experiments indicate that, where the stubble and straw left on the field are sufficiently heavy to burn, firing the fields promises to be an effective method of destroying weevils in the peas. Examinations showed that from 99 to 100 per cent of such weevils can be killed by burning the stubble and straw. Although burning stubble and straw prevents their use for fertilizing purposes and causes some change in the method of handling fields, it will make possible the continued production of the field-pea crop provided the garden peas and the entire harvested crops are properly handled. This phase of control is still under investigation.

Reports of the pea-weevil situation in the Willamette Valley and on the hibernation habits of the pea weevil have been prepared and published.

INSECTS AFFECTING CURED TOBACCO

In accordance with provision made by Congress, an investigation of insects affecting cured tobacco was started July 1, 1930. Upon the recommendation of the president of the Tobacco Association of the United States, headquarters for this investigation were first established at Danville, Va. The discovery of the moth *Ephestia elutella* Hbn. infesting stored leaf tobacco in Richmond, Va., however, necessitated the transfer, on May 26, 1931, of headquarters from Danville to Richmond.

A preliminary survey of conditions throughout the bright-tobacco belt, including points in Georgia, South Carolina, North Carolina, and Virginia, has indicated the seriousness of the insect problem, and has been met with an instant and enthusiastic response from the industry. Wherever possible, the bureau officials have cooperated with firms conducting commercial fumigations of tobacco to determine the effectiveness of control measures applied under varying conditions for the control of the tobacco or cigarette beetle. These experiments have involved the fumigation of some 16,000,000 cubic feet of storage space and some 71,000,000 pounds of tobacco. Over 15,000,000 cubic feet of space was fumigated with hydrocyanic acid gas, over 500,000 cubic feet with carbon disulphide, and very small areas were fumigated with ethylene oxide and the mixtures of ethylene oxide and carbon dioxide.

An important development of the year was the discovery, on August 8, 1930, of a heavy infestation of *Ephestia elutella* in leaf tobacco in Richmond, Va. This is the first record of the appearance of this pest attacking leaf tobacco in the United States. The infestation was general throughout about 8,000,000 cubic feet of warehouse space holding about 31,000,000 pounds of leaf tobacco, mostly of the flue-cured variety, and valued at about \$10,500,000. The infestation was heaviest in the brightest and most valuable grades. Scouting operations, immediately instituted after the discovery of the pest, indicated that the *Ephestia* was confined to a very small area in Richmond and, fortunately, one isolated from other tobacco establishments in that city. No other instances of infestation were found in tobacco storage throughout the bright-tobacco belt, and it is hoped that the large-scale fumigations immediately authorized by the department have resulted in stamping out this pest.

Several articles giving information regarding *Ephestia elutella* as a pest of cured tobacco have been published or are in the process of publication.

A thorough study of the biology of insect pests of cured tobacco and of the methods for their control has been begun.

FLOUR-MILL INSECTS

The investigation of insects affecting flour mills has been continued during the year, with headquarters at Manhattan, Kans., and Sligo, Md. The work in the southwestern milling district has been confined mostly to determining the relative value of various common commercial fumigants, and in developing a program of control that will be less expensive and yet assure satisfactory freedom from insects. Some attention has been given to vault and warehouse fumigation in flour mills, and to the destruction of insects in the stream of wheat as it enters the mill. It is believed that the insects brought into the mill from the elevator bins along with the stream of wheat are largely responsible for reinfesting milling equipment that apparently has been successfully treated by heat or fumigants. Equipment for heating grain as it enters the mill has been used as a basis for this experiment, but convincing data have not yet been secured.

An intensive study of the biology of the insects chiefly responsible for the infestation of export flour has been continued, and a preliminary report on the life history of the flour beetles, *Tribolium confusum* Duv. and *T. ferrugineum* Fab., has been prepared. It was found that adult beetles may live two years or more and that the female beetle may lay nearly 1,000 eggs over an oviposition period of more than a year. During warm summer weather the life cycle is normally completed in about six weeks but may be prolonged to four months on the less nutritious foods and at lower temperatures.

The predacious mite *Acarophenax tribolii* Newst. and Duv. was first recorded as being observed in North America during the year. It was found in Virginia, the District of Columbia, Maryland, Mississippi, and Texas. The only previous recorded hosts are the tenebrionids *Tribolium confusum* and *T. ferrugineum*. Other hosts found infested are *Gnathocerus cornutus* Fab., *Palorus ratzeburgi* Wissm., and *Latheticus oryzae* Waterh. The young female mites live first upon the adult beetle, later migrating to an egg; they then become greatly distended and die, the young soon afterwards emerging from the parent's body as adults. Ordinarily this mite seems to be of little economic importance.

INSECTS AFFECTING STORED GRAIN

The report of last year announced the discovery by department experts of the ethylene oxide-carbon dioxide mixture as an effective fumigant for grain in terminal elevators. Experiments with this fumigant have been continued during the year with gratifying results, and many thousands of bushels of wheat have been successfully fumigated without fire or explosion hazard and with no danger to the operator or injury to the wheat. Publications have been prepared and are now available for distribution describing this method of fumigating elevators.

A new departure in the investigational work of the year has been an attempt to introduce the ethylene oxide-carbon dioxide mixture in the form of a vapor or gas into the column of wheat by means of a piping system permanently installed in the elevator bin. After the bins have been filled and closed the vapors are introduced directly from the steel cylinders containing the fumigating mixture. It is hoped that this method will prove more satisfactory than shoveling the ethylene oxide-carbon dioxide snow mixture into the stream of wheat entering the bin, as described in the last report. The results of experiments already conducted are very encouraging. Laurel Duval, of the New York Produce Exchange, the Carbide & Carbon Chemicals Corporation, and the Bureaus of Entomology, Chemistry and Soils, and Agricultural Economics are cooperating in this work.

The study of the rice weevil as a pest of corn on southern farms has continued during the year. Whereas several years ago the ears of corn grown on St. Simon Island, Glynn County, Ga., were infested at harvest time to the extent of 80 to 90 per cent, and corn in storage there was always destroyed before May following harvest, the construction of fumigable bins or cribs and the treatment of the corn in the cribs after harvest and again in the spring before May 1 has reduced field infestation at harvest time to about 1 per cent of the ears. This and other work in the southern corn belt indicate that each locality raises its own weevils, that there is very little migration of weevils from farm to farm, and that where buildings on farms are reasonably well separated the percentage of ears infested with the rice weevil at harvest time is dependent almost entirely upon the amount of untreated corn in storage on the farm after May 1.

BEAN WEEVILS

The bean-weevil investigations were established at Modesto, Calif., in January, 1928, in response to an urgent call for assistance made by the bean-growing interests of that section. At all times the bureau agents have had the most hearty cooperation of warehouse operators, bean growers, and State and county agricultural authorities and local chambers of commerce.

During the year the work has been continued along lines discussed in previous reports. The work of detecting and stamping out infestations on ranches and in storage has been continued. About 4,650 samples of beans taken from lots consigned to warehouses by farmers were examined during the period between September, 1930, and February, 1931, and about 30 per cent. of the samples were found infested. Because of the large carry-over from the 1930 crop stored in warehouses, about 1,400 additional samples were examined during the March-June period of 1931.

While information gained from examination of these samples has been used to the great advantage of both producer and warehouseman, since it has indicated need for treatment to prevent unsuspected deterioration of the crop in storage, this work was undertaken primarily as part of a large and long-continuing research project of which the object is to determine whether it is possible to bring an important and widespread pest of a com-

mercial crop under satisfactory control by intelligent application, throughout an entire district, of remedial measures such as the destruction of weevils in storage. The conditions with regard to bean weevils in the Modesto district have improved each year since 1927, and it is believed that this improvement is the result of this work.

HOUSEHOLD INSECTS

Of special interest during the year has been the continued improvement of a method of storing furs and fabrics by combining tight storage with effective fumigation. Observations thus far indicate that this method of storage in specially constructed burglar-proof and fire-proof vaults is dependable. So far as can be determined from experience extending over six or seven years, it can be followed without affecting the luster or other characteristics of tanned furs and with complete effectiveness in destruction of insects.

The work with mothproofing solutions, mentioned in a previous report, has been continued during the year and a special study of the value of paradichlorobenzene as a control for household pests, particularly clothes moths, has been undertaken and is still in progress.

INSECTS AFFECTING CONFECTIONS AND NUT MEATS

The investigation of insects affecting confections and nut meats has continued during the year. Special attention has been given to experiments furnishing data on the best methods of protecting the raw products of the industry from insect attack.

INSECTS AFFECTING MAN AND ANIMALS

These investigations have continued under the direction of F. C. Bishopp.

SCREW-WORM FLY AND OTHER BLOWFLIES

Special attention has been given to increasing the effectiveness of controlling the screw worm and fleece worm by flytrapping and to determining the true value of different methods of trap operation. The large-scale range-trapping experiment has been continued and enlarged. The area selected for this experiment is in the rough range country in Menard County, Tex., where screw worms are very destructive and where the ranchmen have shown a splendid spirit of cooperation. The experimental area now covered by flytraps is somewhat more than 100,000 acres. The check, or untrapped, area used for comparison contains about 133,000 acres. Throughout these two areas are being kept records of the number of screw-worm and fleece-worm cases and the approximate number of treatments required to cure them, the kind of animals attacked, and the probable cause of the infestation. Careful checking of the number of flies present in the trapped and control areas showed that apparently the trapping operations during the past season had decreased the fly population 36.2 per cent. The value of the operation of traps is indicated by the fact that 1,945 quarts of flies were captured in 269 traps between March 2 and April 10. Investigations of various factors influencing the number of flies caught have been continued. These factors in-

clude trap location, size of bait used, frequency of adding bait and water, and kind and amount of materials added to the baits to prevent larvæ from breeding in the bait pans. Definite conclusions can be drawn only after accurate data have been accumulated over a period of several years.

Some attention has been given to modifying trap design. The large box trap developed recently has been tested under practical conditions and appears to have some distinct advantages. It not only captures large quantities of flies but also facilitates the disposal of carcasses. A portable trap sufficiently large to take medium-size carcasses was designed, and a number of practical tests made with it. In one of these tests 28 gallons of flies were captured in six weeks. Efforts to develop parasites on the fly larvæ and pupæ in these traps have been rather disappointing. Certain parasites and predacious enemies, however, appear to be of value in reducing the number of screw worms in some localities. Investigations were therefore undertaken to determine more accurately the distribution and local abundance of these beneficial insects.

The abundance of the larval parasite *Brachymeria fonscolombei* Dufour on ranches in the vicinity of Uvalde, Tex., where releases of this parasite were made last year, was somewhat less than last season, the average parasitism this year being about 30 per cent, whereas the previous year it was more than 39 per cent. The pupal parasite *Mormoniella vitripennis* Walk. showed a slight increase, however, the percentage of parasitism being 1.42 as compared with 1.25 the previous season. Parasitic wasps of the genus *Aspicera* appear to be of some practical value, and their distribution and life history and the methods of propagating them for dissemination are being studied.

Investigations have been continued on methods of protecting infested livestock from further attack. Designs for screening houses for this purpose have been given consideration and tests have developed the practical value of such houses under ranch conditions, especially where purebred animals are to be treated. The location of hospital pastures has been found to have a distinct bearing on the rapidity with which screw-worm cases can be cured. By the simple method of changing the hospital pasture to high ground, free from underbrush and with comparatively few trees, the recovery of screw-worm cases has been materially facilitated.

CATTLE GRUBS

Certain phases of the cattle-grub investigations have been continued in cooperation with the Bureau of Animal Industry. The efficacy and ease with which insecticides can be applied to the backs of cattle have been increased. Derris and its derivatives appear to be most promising, particularly since there is no danger of poisoning livestock with them.

Investigations of the distribution of the northern cattle grub indicate that this serious pest is still spreading. It is increasing in abundance in the areas infested and its presence in Oregon was determined for the first time.

On account of the prevalence of the idea that the use of fly sprays is an effective method of control, tests have been carried out to

determine this point. The results of the experiments this year indicate that neither light nor heavy oil sprays have significant effect on warble infestation.

Investigations of the factors responsible for the natural freedom of certain areas from cattle grubs were continued, particularly in the Red River Valley of the North. In this, the third year since the laboratory has been located at Fargo, N. Dak., an exceptionally dry spring prevailed and therefore the experiments in this region were seriously hampered again. The fact that cattle grubs appeared in certain parts of the Red River Valley in the spring of 1931 is added evidence that the combination of type of soil and climatic factors has an important bearing on the presence or absence of infestation in that area.

SHEEP SCAB MITE AND GOAT LICE

The cooperative work on these important sheep and goat parasites was continued with the Texas Experiment Station at Sonora, Tex.

The work on the sheep scab mite has been terminated and a report on the results of this investigation is being prepared for publication. A number of large-scale tests of sulphur dips against goat lice were carried out. The efficacy of the finely divided sulphurs in combination with a small amount of soap has been fully demonstrated against all species of goat lice, and as a result eradication of goat lice on a range basis, or throughout large areas, appears to be entirely practicable.

EYE GNATS

It has been established that eye gnats (*Hippelates* spp.), which so seriously hamper agriculture and other activities in certain valleys in southeastern California and in parts of the Southern States, breed in decaying organic material. These insects have been reared on various kinds of vegetable and animal refuse. This strongly indicates the importance of more adequate disposal of home and farm wastes. Much attention has been given to the development of cheap and effective traps for use against the gnats and several different types which work well have been tested. The season's work seems to show that extensive trapping not only greatly reduces the annoyance from the gnats but may serve gradually to reduce the pest in a given locality. These trapping operations, which have been carried out in cooperation with local authorities, have resulted in a decrease in the number of cases of eye diseases which have heretofore seriously hampered work and interfered with schools.

MOSQUITOES

Additional funds provided for mosquito work in the Northwest permitted the establishment of a laboratory at Portland, Oreg., for a study of the flood-water mosquitoes which have been an extremely serious pest in that region. It has been determined that the two principal mosquito pests of this region are *Aedes vexans* Meig. and *A. aldricchi* D. and K. The outbreaks are clearly associated with the appearance of pools along the rivers after floods. These mosquitoes pass the winter in the egg stage, and when the eggs are sub-

merged in the spring they hatch and the young develop in the pools in incredible numbers. Some of the eggs remain unhatched until they have been submerged several times. A survey of the principal breeding areas along the lower Columbia River has been made, and experiments with different methods of control have been carried out in cooperation with the local authorities. The timely application of distillate oil was found to destroy a large percentage of the larvæ.

The laboratory for the study of malarial mosquitoes was moved from Mound, La., to Orlando, Fla. The extensive studies of natural environmental conditions in the Anopheles-breeding and nonbreeding waters of the Louisiana delta region were thus terminated, and the material gathered there was prepared for publication. The analysis of these data shows that all waters studied were apparently suitable for Anopheles breeding from the standpoint of larval food supply, the abundance of larvæ depending upon the kind and amount of protection from natural enemies afforded by various plants and by floating débris. The range of hydrogen-ion concentration in the breeding and nonbreeding waters was found to be essentially the same, and practically all waters were alkaline in reaction. Investigations of the important pest mosquito *Mansonia perturbans* Walk. were continued in Florida. The peculiar habit of the larvæ and pupæ of this mosquito, which pierce submerged stems and roots of plants to obtain air, makes their control very difficult. In central Florida larvæ were found attached to the following plants: Pickerel weed, arrowhead, cattail, frog's bit, yellow waterlily, and waterhyacinth. Sluggish streams or marshes having weedy bottoms and in which the above plants grow in abundance are the principal breeding places of this mosquito. Life-history data indicate that there are two broods of adults in Florida, as two definite peaks of abundance were noted during the season, the first occurring early in May and the second about the first of August. Discovery that the young larvæ live at the surface of the water for a short time after the eggs hatch, and that the pupæ rise to the surface of the water several hours before the adults emerge, suggests that oiling may be effective if it is done at the proper time.

Certain foreign reports have directed much attention to the question of the relationship between the extensive cultivation of certain legumes and the incidence of malaria. Numerous requests for information on this subject prompted the conduct of some experiments to determine whether Anopheles mosquitoes would, in fact, feed on these plants and whether the nectar would adversely affect the mosquito or the malarial organism in it. The preliminary experiments along this line indicate that the mosquitoes would not feed to any extent on these legumes.

SAND FLIES

Increased funds were granted to the bureau to begin work on the problem of the sand fly in the Southeast. A laboratory was established at Charleston, S. C., and information was gathered on the species of sand flies concerned, the distribution of these insects as pests, and the environmental conditions favoring their abundance. Prior to the beginning of these investigations practically no authen-

tic information had been obtained on this important group of insects. Sand flies were found to be of some economic importance along the entire Atlantic seaboard from Massachusetts to Florida, and in all the Gulf States. They were most abundant and annoying near salt water at fresh-water inlets. However, certain species were also reported from the interior. Several species of sand flies are involved and they appear to have a more or less restricted seasonal incidence. The young of certain of these species have been found in the short-grass and in the mangrove marshes. The larvæ have been taken in considerable numbers from fiddler-crab holes and in the silt along waterways and ditches. Investigations have been undertaken to determine the biologies of the different species and to study their food requirements in detail. It has been shown that the sand-fly larvæ develop very slowly in cool weather and can pass the entire winter in the larval stage; also that the larvæ are capable of withstanding temperatures as low as 40° F. Some preliminary investigations with repellents indicate that fair protection from these insects may be obtained by the use of the oils of camphor, bay, sassafras, and pine. Pure glycerin was found to be even more effective than the essential oils. Oil of pine tar and certain hardwood oils were found to be effective for some time in keeping sand flies from passing through screens, and kerosene applied to screens gave protection throughout a night.

RAT MITE AND ENDEMIC TYPHUS

For some time investigators of this bureau have suspected from epidemiological data a connection between the tropical rat mite (*Liponyssus bacoti* Hirst) and endemic typhus. Experiments conducted in cooperation with a medical research worker have proved that this mite not only causes a dermatitis of man but that it is capable of transmitting endemic typhus. This is a discovery of outstanding importance, as the disease is widespread in this country. The methods used and results attained in this study were demonstrated at the general exhibit of the American Medical Association at Philadelphia in June, 1931, and received the silver award of the association.

REINDEER INSECTS

Investigations of two very important reindeer botflies, *Oedemagena tarandi* L. and *Cephenomyia trompi* L., were conducted in cooperation with the Alaska Agricultural Experiment Station with headquarters at Nome, Alaska. The methods of handling the reindeer on the range make the application of control practices extremely difficult. An experiment was undertaken to decide the feasibility of reducing these pests by pasture rotation. The results of this test can not be determined for several months. A number of reindeer were sprayed with different insecticides. Their dense coats make it extremely difficult to bring the insecticides into contact with the skin, and special nozzles and methods of application are being developed. Life-history and seasonal-history studies of the insects are also in progress.

POULTRY PARASITES

Experiments have been conducted to determine the efficacy of applying nicotine sulphate to the roosts for the control of lice, mites, and other ectoparasites of poultry. These experiments showed that a light application of this material shortly before the fowls go to roost would effect a high degree of control of the lice, but that at least three treatments at 8-day intervals are necessary under ideal conditions to eliminate all lice from a flock. It was concluded that where eradication was desired the use of sodium fluoride would be most economical and certain. Nicotine sulphate did not destroy sticktight fleas attached to fowls, but its use as a spray when diluted 1 to 10 gave satisfactory control of the common chicken mite.

The occurrence of the pigeon fly (*Pseudolynchia maura* Bigot) as a serious factor in commercial loss led to some studies of this pest. Treating the birds with any one of several different insecticides and at the same time systematically destroying the pupæ in the nest boxes gave practical control.

MISCELLANEOUS WORK

Preliminary investigations of the transmission of relapsing fever of man by the tick *Ornithodoros turicata* Dugès were carried out. A well-defined case of the disease developed in one of the investigators following the bites of this tick, which occurred in a cave. The transmission of this disease by *O. turicata* was demonstrated by allowing specimens of the tick collected in nature to feed on guinea pigs.

A severe outbreak of buffalo gnats occurred in portions of Mississippi and Arkansas in the spring of 1931, and a preliminary investigation showed that *Eusimulium pecuarum* Riley was the species concerned. The outbreak was unusual in that it occurred in the absence of overflows which usually have been associated with such events. Apparently the extremely low level of the streams last year induced the growth of vegetation along their beds, and the return of normal water levels created places of attachment and development.

BEE CULTURE

The Division of Bee Culture is under the direction of James I. Hambleton, with headquarters at Somerset, Md.

INSEMINATION OF QUEEN BEES

The work on hand insemination of queen bees at the southern laboratory has been continued, but has been confined almost entirely to a simplification of the method. Hand-mated queens have been compared with naturally mated queens to determine the degree of insemination. Failure to mate has caused a heavy loss of queens by breeders over considerable portions of the South this year. Observations are being made to determine the cause of this loss. A critical study of the effect of food, colony development, and age upon the sexual development of both queens and drones is under way. Several hundred queens have been collected, preserved, and sectioned in studying the correlation of the number of egg tubules in the ovaries with the prolificacy and breeding qualities of queens.

At Somerset improvements have been made in the Watson method for artificial insemination of queen bees. By the use of a special clip and an accessory rod it is possible to hold the tips of the queen's abdomen apart during the operation. This frees the left hand, which under the old method held a pair of fine forceps which kept the abdominal tips separated. By the use of the clip the abdominal tips can be spread wider apart, and the danger of injuring the delicate tissues of the queen bee is minimized. A change has also been made in the manner of confining the queens during the test period after the operation. The queens are now kept in 10-frame hive bodies screened into two or more compartments, each with its own entrance. The hive bodies are tiered in the usual manner. Virgins from the F_2 generation have been used during the year, and between 30 and 40 per cent of the queens operated upon have shown some degree of insemination. Improvements have also been made in the technic of catching and marking drones, so that it is possible to keep an accurate record of the parentage and age of the drones used in the experiments. The use of the electric incubator in rearing queen bees has been quite successful and conserves the supply of bees necessary for the work. Improvements have also been made which facilitate grafting, so that it can be done with success even on unfavorable days. A paper dealing with the artificial insemination of queen bees was prepared.

POLLINATION OF RED CLOVER

Rather significant results were obtained in the experiments on pollination of red clover by honeybees. The experiments were begun at Holgate, Ohio, last summer in cooperation with the Bureau of Plant Industry. Some colonies of honeybees were concentrated in the vicinity of red-clover fields, and in other cases cages were used to confine honeybees to definite plats of red clover. It would appear that the bees were an important factor in the set of red-clover seed under the conditions existing in Ohio during the summer of 1930, although because of the drought the conditions were probably not average. The experiments are being continued, and if this season is normal it will be possible to compare the results of the two seasons' work and arrive at some definite estimate of the value of honeybees in the pollination of this legume. A report on the results of the work in 1930 was submitted, but it is planned to wait until this year's work is completed before publishing a full report.

Rather exaggerated claims have been made that Caucasian bees are more effective in pollination because of their inclination to fly under more adverse weather conditions than do Italian bees. In order to learn whether such a difference actually exists, preliminary experiments were begun this spring.

FLIGHT OF THE BEE

The studies of the flight range of the honeybee were continued at the intermountain laboratory during the summer of 1930 in an effort to determine the distribution of bees from an apiary located within a source of nectar. Observations were made on the flight of bees from apiaries located in the San Luis Valley of Colorado and

in the vicinity of Laramie, Wyo. It was found that the bees have a tendency to concentrate their flight in only one or two major directions from an apiary, even though nectar-secreting plants of equal attractiveness are present in other directions and closer to the colonies. Bees were found to fly as far as $2\frac{3}{4}$ miles for nectar and pollen in the major direction of flight, neglecting nearer fields in other directions. It was not possible to explain this concentration of direction of flight as caused by weather or topographical differences in the terrain. Where several apiaries were located in fairly close proximity to each other, the bees from the different apiaries did not seem to trespass on each other's fields to any great extent.

Because of the need for accurate knowledge on the rate of flight of bees from colonies and packages, work has been started at Somerset, Md., to devise a photoelectric apparatus which will accurately and chronologically record the flight of bees from full working colonies. This type of apparatus has long been needed in experiments dealing with the activities of field bees.

DISEASES OF BEES

Reports have been received from various parts of the country that beekeepers and inspectors have had difficulty in distinguishing between American and European foulbrood in the apiary, because under certain conditions the scales of the two diseases closely resemble each other. A study of these confusing cases showed that with some practice the two diseases can readily be distinguished by the odor from a single scale. Familiarity with the odors typical of the two foulbroods facilitates making an accurate diagnosis in the apiary. A brief report of this work was published in an outside journal.

In connection with the use of 20 per cent formalin-water solution for disinfecting American foulbrood combs, preliminary results indicate that the temperature at which the combs are treated is a highly important factor, but has largely been neglected by practical beekeepers. Tight covering of the treated combs after they are removed from the disinfectant solution is of considerable importance in prolonging the period of disinfection.

In certain sections of the Western States heavy losses of adult bees have occurred from a condition commonly known as paralysis, the exact cause of which has never been determined. From cage experiments with sick bees obtained from Nevada it appears that the condition can be transmitted to healthy bees, thus demonstrating its infectious nature, although it has not been possible to inoculate strong colonies under experimental conditions.

During the year 905 samples of brood and adult bees were submitted for diagnosis. This number included numerous samples of comb treated for American foulbrood, which had been sent to the laboratory for sterility tests. Ninety-six imported queen bees were received and examined for *Acarapis woodi* Rennie, a mite parasitic on the honeybee, which occurs in various European countries. Mites were not detected in any of the shipments. The disease caused by the mite, commonly called Isle of Wight or acarine disease, has never been reported as occurring in the United States.

Studies of the spread of American foulbrood in commercial apiaries in relation to the minimum number of spores of *Bacillus larvae* necessary to produce the disease are still in progress at the intermountain laboratory, Laramie, Wyo. A series of colonies of different strains of bees were fed the previously determined minimum infective number of spores, 50,000,000 per liter, without developing disease in any case. Individual larvæ were also fed a definite number of spores to determine the minimum infective dose of spores per larva. While difficulties were encountered in these preliminary experiments, one series of individual larvæ fed 10,000,000 spores per larva developed disease. Although the results are as yet insufficient to be conclusive, they again seem to indicate that the minimum infective dose of spores of *Bacillus larvae* necessary to produce disease either in a colony or in an individual larva must be relatively large. Studies on the minimum number of spores of *Bacillus larvae* per cubic centimeter of seeding that would produce growth on artificial culture media have been continued. The smaller number of spores tended to require longer periods of incubation in order to produce growth, and fewer than 50,000 spores per cubic centimeter produced no growth even after 30 days' incubation. There was, however, a variation in results caused by the variable character in the spores known as dormancy, which prevented more than a slight negative correlation. By means of centrifugation and microscopic examination it has been possible to demonstrate the presence or absence of spores of *Bacillus larvae* in commercial honeys, and although the method employed is not satisfactory or reliable in the case of negative results, it was possible to demonstrate the presence of spores in 13 out of 133 samples of commercial honeys bought on the open market at widely scattered points in the United States. Whether the 13 samples contained sufficient numbers of spores to inoculate healthy colonies was not determined. These studies are being continued. The results of the work thus far have been incorporated in a paper submitted for publication.

INTERMOUNTAIN LABORATORY

The work in the Intermountain States dealing with the cost of honey production and with apiary management, which has been conducted in cooperation with the Bureau of Agricultural Economics and State beekeeping specialists, has been terminated. All the records from the cooperators are now being assembled preparatory to issuing a final report of the work in this region. Similar work with cooperators is being continued in the so-called "white-clover" States of the Great Lakes region. If the records from the cooperators at the conclusion of the season are found adequate, it is planned to discontinue the work in this region.

Studies of various methods of wintering in the intermountain region were continued. Colonies going into winter quarters with two or three times as many young bees as the average colony has, were found to consume more stores, but considerable differences in their condition were found in the spring, some coming through the winter no better than average colonies while others had more than the average quantity of bees and brood. One colony, which was placed in winter quarters presumably with old bees only, wintered

successfully and a sufficient number survived to raise a new generation in the spring, which later built up to average size during the dandelion flow. No significant variation between the stores consumed during the winter and the number of frames of brood in the spring was found in colonies that were wintered by four common methods.

SOUTHERN LABORATORY

Investigations of importance to the beekeeping industry in the Southern States have been continued at Baton Rouge, La., in cooperation with the Louisiana State University. In response to requests from the producers and shippers of package bees and queens, a study of the various types and sizes of shipping cages was made for the purpose of reducing, if possible, the number of those types and sizes and of minimizing the loss of bees in transit. The shipper, the receiver, and the public carrier have been dissatisfied with existing conditions in the package-bee business, but it has been extremely difficult to obtain the cooperation among the various factions which is necessary in order to solve their problems satisfactorily. Each producer designed and used a cage which seemed to him ideal. Many had undoubted merit, but none was entirely satisfactory and only a few shippers seemed willing to make compromises in the interest of simplicity and standardization. The public carriers charged a high rate for transportation because of the risk of losses in transit, and because of the wide differences in type and size of cages received for shipment. The receiver of package bees never knew what kind of a package to expect when he ordered bees from a southern shipper, and as a result there was much dissatisfaction. After interviewing many shippers and studying many types and sizes of cages, it was finally possible to recommend a minimum number of styles of cages, and these have been described in a multigraphed circular entitled "Recommendations for Shipping Cages for Bees." It is hoped that the recommendations embodied in this circular will serve as a basis for improving the package-shipping business, and that the adoption of uniform cages and methods of shipping may bring about a reduction of transportation costs. Investigations are also in progress to learn the most suitable size of package per unit of adult bees, and the effects of foods of various kinds and of high and low temperatures during transit.

Considerable attention is being given to the management of colonies for straight honey production under southern conditions, and to the superseding of queens, particularly those sent through the mails or by express in packages.

The work on honey and pollen plants in the South has been continued, and interesting facts about the importance and value of certain honey plants have been learned by placing colonies of bees on scales in the care of collaborators living in areas where a single species of plant predominates. Emphasis is being placed on the influence of soil and environment on nectar secretion, with the probability that the study will be concentrated on a single species of plant grown under closely controlled conditions. An herbarium has been established which already contains over 100 mounted, identified, and labeled nectar and pollen plants. In conjunction with the study

of honey plants, scale records of the weight changes of a colony of bees are being compiled.

PACIFIC COAST LABORATORY

As a result of funds being made available for establishing an apicultural research laboratory on the Pacific coast, Davis, Calif., was chosen as the site of the laboratory, and actual work was started in March, 1931, under a cooperative agreement with the University of California. Because of the lateness of the season, it was not possible to begin work on the two major problems selected for study—namely, an economic survey of beekeeping on the Pacific coast and a survey of existing conditions relative to bees and pollination.

An economic survey of beekeeping in Oregon is to be commenced in January, 1932, in cooperation with the Oregon Agricultural College. This survey will cover beekeeping enterprises in the major honey-producing districts of the State. A similar survey is planned for California although the time when the work can be started has not been determined. A thorough survey of beekeeping conditions in California is greatly needed. Changes in agricultural practices have caused considerable upsets in what were at one time proved and successful methods of producing honey. In the San Joaquin and Sacramento Valleys growing alfalfa for seed has almost ceased, and bees now have opportunity to store alfalfa honey only in the Imperial Valley. Large areas have been put into fruit and vegetables, which produce early nectar; and into beans and cotton, which produce nectar later in the season, leaving a long period of dearth when the bees have no source of supply and must consume the stores already gathered. In a poor season many colonies starve. Either the bees in these areas must be moved to new locations or new systems of management must be inaugurated, if honey production is to be maintained on a profitable basis.

At the end of the early fruit bloom, colonies of bees in the San Joaquin and Sacramento Valleys in California become exceedingly populous at a time when there is no nectar to be gathered. As a result, producers of this region have found it advantageous to ship package bees into Canada or elsewhere either for pollination purposes or for honey production. It is possible that these surplus bees can also be used in the orange region, where colonies are usually too weak to store a full crop of orange honey.

Preliminary studies of the possibilities of utilizing the nectar-producing flora of the foothills and in the Sierras adjoining the San Joaquin and Sacramento Valleys have been made. Because of the prevalence of California buckeye, it is unwise to move bees into new territories until some way is found to eliminate the danger of buckeye poison. There is a demand that the whole region of the Sierras be investigated with relation to its possibilities in honey production. Reports and the results of a few experimental colonies indicate that there are almost unlimited areas which promise to be excellent for commercial honey production, and which may be utilized by the beekeepers in the San Joaquin and Sacramento Valleys, who have suffered constant reverses during the past few years.

MISCELLANEOUS

Phenological records for the principal nectar-secreting plants in the United States are still being received. This work is handled largely through correspondence and progress is necessarily slow. All the records have been classified according to regions and plants, and many valuable data have been gleaned from old reports and correspondence in the files of the division.

Samples of beeswax known to contain no foundation and to be composed entirely of pure beeswax were obtained through the field stations and through individual beekeepers for the use of the wax laboratory of the Bureau of Chemistry and Soils.

A collection of unheated honeys from the principal commercial sources, and of samples of flowers from which these honeys were produced, is being assembled for transmittal to the State chemical laboratory at Bremen, Germany, for analysis of diastase content. The work conducted in this country indicates that the diastase content of a number of American honeys is considerably lower than that of some German honeys, and the German law requiring a diastase content above a certain minimum works a hardship on the producers and dealers in honey with a natural diastase content below the German requirements. It is hoped that these tests will help to overcome the prejudice against those honeys naturally low in diastase, which are now admitted to Germany only as second-class or inferior products.

The specifications of the United States grades for honey have been rearranged, and a revision of Circular 24, United States Grades, Color Standards, and Packing Requirements for Honey, is planned for the coming year.

Preparations are under way to equip a model honey-handling house at Somerset, Md. Through all the years since the establishment of the bee-culture laboratory such equipment has not been available, and its lack has made it impossible to undertake certain technological studies of honey which are of great importance to the industry.

Lack of funds and personnel has again made it necessary to refuse many calls to participate in meetings of beekeepers' organizations, although members of the division have attended a number of important meetings. In many cases the organizations in question assumed part of the travel expenses.

Many requests have been received for photographs and information for the use of special writers, and educational material on bees and honey has been furnished to schools and the press in more than the usual quantities. Numerous radio talks on bees and honey have been prepared and broadcast over several of the national radio chains. Demands for manuscripts for radio talks have materially increased.

The library and bibliography of beekeeping literature have been constantly added to. Numerous requests have been received for special bibliographies, and these have been supplied. The old, important beekeeping literature is becoming scarce owing to the demand for it brought about by the establishment of several new beekeeping libraries.

TAXONOMY AND INTERRELATIONS OF INSECTS

TAXONOMY

The investigations under this unit have continued under the direction of Harold Morrison.

The service character of the work has continued to dominate the activities of the specialists in the unit. It concerns the identification of insects in all orders, and is of benefit to all branches of the Government service, as well as to officers of State experiment stations, university staffs, and many individuals interested in entomology both in this country and abroad. During the year a total of 17,430 identifications were made by members of the staff or by affiliated workers. These identifications were distributed as follows:

Group	Identifications
Beetles.....	4,407
Moths.....	2,565
Flies.....	2,259
Hymenoptera.....	3,240
Grasshoppers, etc.....	832
Ectoparasites and mites.....	590
Bugs.....	1,424
Scale insects.....	2,078
Miscellaneous.....	35
Total.....	17,430

The work of organizing and arranging collections to make them available for study and identification has been continued in practically all the groups during the year, but has been most active in Coleoptera (beetles). Renewal of the taxonomic work in the economically important group of Hemiptera (plant bugs) has been made possible by addition of two specialists to the staff. It is hoped to engage, very soon, a specialist for the group including mosquitoes and other blood-sucking flies. Taxonomy of the group containing cutworms and related moths, which includes many important farm and garden pests, has for some time been without the services of a specialist. Beginning with the next fiscal year it will be supervised by an entomologist transferred from the Mediterranean fruit-fly project of the Plant Quarantine and Control Administration. Negotiations have been completed for the transfer, early in 1932, of a specialist from the gipsy-moth work of the bureau to assist in taxonomic work on parasitic insects in the Braconidae group. Additional specialists are acutely needed for work on such economic groups as May beetles, click beetles (known in the larval stage as wireworms), and sawflies (a superfamily of Hymenoptera which includes destructive leaf-feeding and gall-making species), and to assist in the study of parasitic wasps and flies (Diptera). Lack of specialists for identification work in minor groups is now being met by such voluntary service as can be obtained on occasion, but can not be commanded, from amateurs and from other specialists.

In spite of the pressure of identification work, progress toward completion of taxonomic studies in many groups has been made. The extensive paper on the classification of coleopterous larvæ has been revised and perfected with a view to its early publication. The following papers have been completed and are ready for publication: A

long manuscript dealing with the Cerambycidae of the West Indies; one on the classification of certain tachinid flies; one describing certain new ichneumon parasites of beetles; a paper on North American chiggers and their classification; some papers discussing the results of field-survey work on chiggers and their hosts; and a paper presenting synoptic notes and describing new species of Hemiptera.

Papers on the following subjects have been completed and published: Revision of two genera of the Scolytidae; on the genus *Perigaster* (family Curculionidae); some short papers discussing the classification of Scarabaeidae or describing new species; and a paper on certain important bethylid parasites of stored-grain insects.

The Barnes collection of Lepidoptera, purchase of which was approved by Congress at the end of the last fiscal year, was transferred to Washington in August, 1930. The specimens and cases were transferred to the Smithsonian Institution for the United States National Museum in January, 1931. The library and some accessory equipment which accompanied the collection were retained by the taxonomic unit of the bureau. According to the inventory supplied with the Barnes collection, it includes approximately 473,000 specimens of North American and Mexican Lepidoptera, as well as important type and other material.

INSECT PEST SURVEY AND PUBLIC RELATIONS

The insect pest survey has continued under the direction of J. A. Hyslop. The work under the title "Public Relations" was authorized under the appropriation for the fiscal year 1931, but owing to difficulties in obtaining personnel was not actually begun until January of that year.

INSECT PEST SURVEY

The activities under this project are concerned with collecting, recording, analyzing, and maintaining permanent records of insect abundance and damage and the publication of a monthly bulletin on current insect conditions and an annual summary of these conditions throughout the United States. This information on insect conditions is supplied through cooperative arrangements with entomologists of the bureau, State entomologists, and others who furnish to this central unit notes on insect occurrence and injury within their own districts. This work is incidental to their other tasks. Maintaining these records and supplying current information on insect conditions is of decided benefit to entomologists and entomological work. The insect-pest survey now has some 94 special collaborators who report monthly, and arrangements have been made to secure information on entomological conditions in the Dominion of Canada, Guatemala, Honduras, Cuba, Porto Rico, Costa Rica, Haiti, Mexico, and the Hawaiian Islands. It also exchanges outstanding entomological information with the Dominion of Canada and the Hawaiian Islands, whose entomological agencies have local surveys similar to that of the Bureau of Entomology. During the year the insect pest survey completed Volume 10 of the Insect Pest Survey Bulletin and the first four numbers of Volume 11, including 560 pages in all.

During the year the insect pest survey added to its permanent record approximately 34,000 notes on domestic insects, covering

8,000 species and 2,500 genera, bringing the total number of notes to more than 112,000, and the number of genera concerned to 5,700. This record is now completely cross indexed according to host plants. Summary cards have been prepared under each insect to indicate its food plants, parasites, and predators, and, if it be a parasite or predator, its various host insects. Maps are in the files showing world distribution, United States distribution, and detailed State distribution of the more important insects.

PUBLIC RELATIONS

This project deals with extension work in applied entomology and is conducted in cooperation with the Office of Cooperative Extension Work and the extension specialists in entomology in the several States. It includes the preparation of educational material in entomology, the planning and supervision of the preparation of educational exhibits in entomology, and general contact work on entomology with motion-picture activities. For the purpose of contacts with the State officials the country is divided into four main districts, and an extension entomologist is assigned to each district to maintain contacts and to furnish the various State officials with the latest information on methods of control of insect pests.

MISCELLANEOUS RESEARCH SUBJECTS

INSECT MORPHOLOGY

In the field of insect morphology R. E. Snodgrass has completed the first part of a study of the morphology of the insect abdomen. Part 1 of this study, covering the general structure of the abdomen and its appendages, will shortly be published in Smithsonian Miscellaneous Collections. Mr. Snodgrass has also practically completed a study of the evolution of the insect head and organs of feeding, which will be published in the Annual Report of the Smithsonian Institution. He has three additional papers now in an advanced stage of preparation, all relating to the morphology of the insect abdomen, including the internal organs.

INSECT PHYSIOLOGY AND TOXICOLOGY

Important work in the general field of physiology and toxicology of insects has been carried on for a number of years in the various divisions of the bureau. During the year this work was established as an independent project serving all units of the bureau, emphasizing and specializing in basic work relating to the chemical control of insect pests. The activities carried on in this section are: (1) Investigations designed to determine basic facts of the physical effect of poisons on major insect groups, with the idea of developing practical leads for improving methods of controlling insects with insecticides; (2) investigations on the vital processes and secretive and excretive products; (3) studies on the behavior of insects under known environmental conditions, to establish a basis for actual determination of results of experiments on attractants, repellents, baits, etc.; (4) research leading toward standardizing methods of experimentation on the physiological reactions, with the purpose of im-

proving methods now used in outlining experiments carried on in the field; and (5) tests to determine the effectiveness of various insecticides such as stomach poisons, contact poisons, and fumigants, such tests being conducted under controlled conditions in the laboratory to evaluate insecticidal compounds or mixtures and to promptly determine those which promise to be useful under field conditions.

The centralization of these basic investigations is in the interest of economy and makes fundamental information available widely and promptly. An important part of this work is done in cooperation with the Bureau of Chemistry and Soils, particularly the testing, with suitable insects, of the various compounds submitted by that bureau.

The work in this field during the year has been somewhat interrupted by changes in personnel and by removal to a new laboratory in Takoma Park, Md. The section is under the direction of F. L. Campbell, with whom are associated a number of highly trained specialists, most of whom were transferred from other divisions of the bureau. Tests of compounds derived from rotenone and of other compounds related to rotenone, and of a series of fluorine compounds, have been made with appropriate insects. These tests were made for the Bureau of Chemistry and Soils. Perhaps the most important published work of the year was the report on the solubility of acid lead arsenate within the alimentary tract of the silkworm. An important phase of this study was the determination that it is possible, through the radioactive-indicator method developed by the authors, to obtain a better understanding of the toxicology of lead arsenate. Three other technical papers in this field have been published during the year.

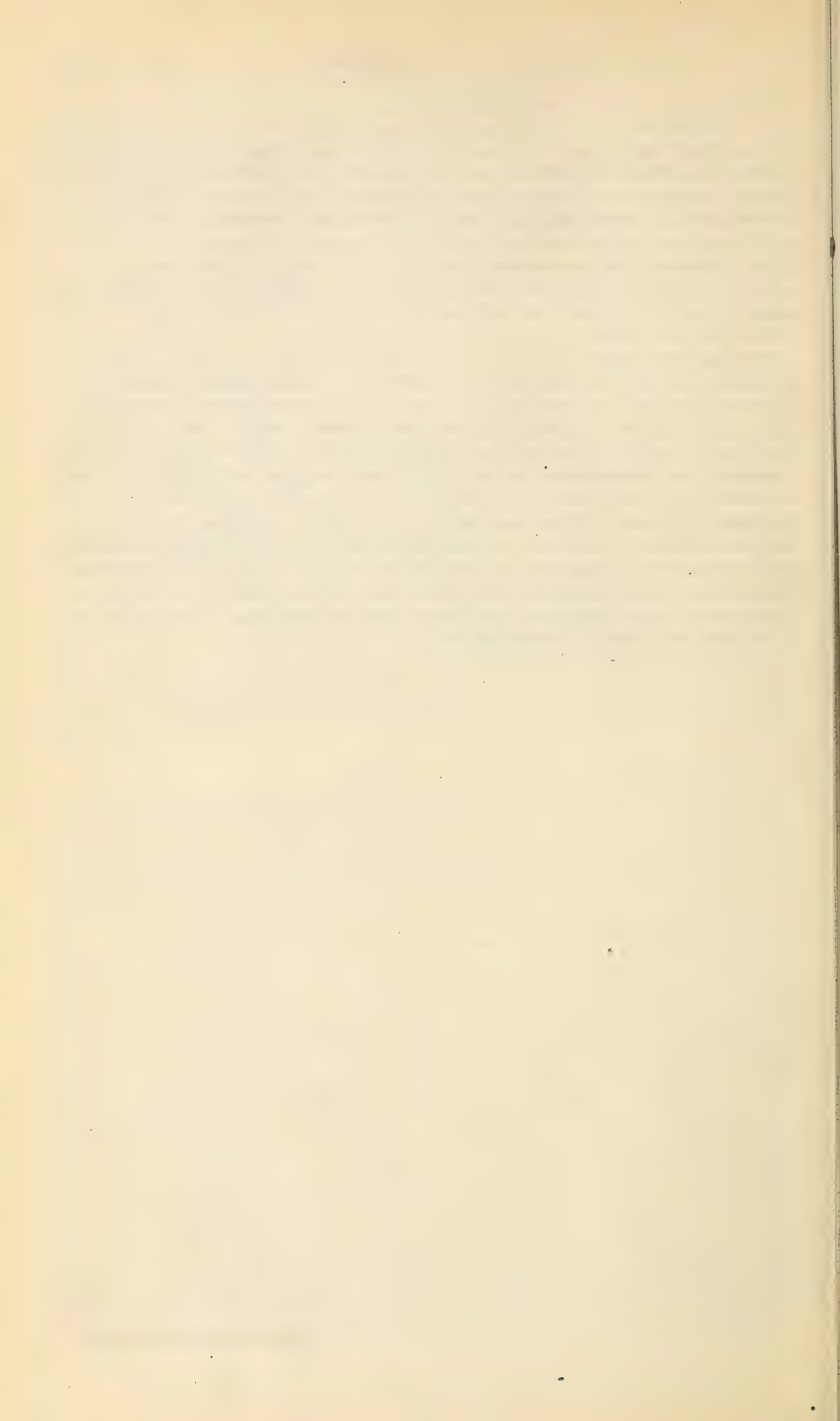
BIOCLIMATICS

The special work in this field has been developed over a long period by A. D. Hopkins, who retired under the age limitation on August 31, 1931. Doctor Hopkins's service in the bureau covers many years, spent largely in the field of forest insects. He developed and established the Division of Forest Insects, but in later years became intensely interested in bioclimatics and has made it his special field. This work involves studies of the broad phases of the relations between insects and environmental conditions affecting their development and abundance. It includes application to the control of insect pests of the principles discovered through investigation. Publication of the more important results in this field is now possible, and the manuscript for such publication was substantially completed before his retirement. With the consent of the Department of Agriculture, Doctor Hopkins has been authorized to arrange for outside publication of this work, which is to be issued in two substantial volumes. Doctor Hopkins's interest in these investigations is such that he proposes to continue them for years, not only to complete the publication of the volumes referred to, but to carry forward investigation in full cooperation with the bureau. He has established, at his own cost, a laboratory and experimental grounds on his property on the Little Kanawha River, near Parkersburg, W. Va., which he hopes will become a permanent station for the study of bioclimatics, not only in relation to insects and their control, but in relation to plants and farm practices generally.

INSECT DISEASES

The study of insect diseases has not been broadly developed in the bureau, but it is very important and warrants extended research. While most insect diseases are influenced by climatic conditions, nevertheless a knowledge of such diseases and means of encouraging them may offer controls which in many instances are equal, if not superior, to those which may be obtained by chemical means or by the aid of such natural enemies as parasitic and predacious insects. G. F. White has continued to be the sole worker of the bureau in this field.

An important part of Doctor White's work this year has been the development, in cooperation with the Division of Insects Affecting Man and Animals, of methods and technic in securing and maintaining stocks of living blowfly larvæ in adequate numbers to be used in the postoperative treatment of osteomyelitis. This work has been done for the information of surgeons and hospital authorities. The extraordinary field of utility for such insect aids was developed by the late William S. Baer, of Baltimore. Doctor White has devised very satisfactory methods of breeding and preparing such material, and his work was made the subject of an exhibit at this year's session of the American Medical Association in Philadelphia. A publication is now being prepared for the purpose of making the description of the method generally available.



REPORT OF THE ACTING CHIEF OF THE OFFICE OF EXPERIMENT STATIONS

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., September 1, 1931.

SIR: I transmit herewith a report of the Office of Experiment Stations for the fiscal year ended June 30, 1931.

Respectfully,

WALTER H. EVANS, *Acting Chief.*

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

The Office of Experiment Stations continued to administer the Federal acts making appropriations for the State agricultural experiment stations and for the experiment stations maintained by the department in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, in compliance with the legal requirement that the Secretary of Agriculture shall ascertain whether the expenditures of the funds are in accordance with the provisions of the acts, coordinate the work of the department with that of the stations, and report thereon. The Federal funds involved amounted to \$4,340,000 (\$90,000 to each State and \$20,000 to Hawaii) provided by the Hatch, Adams, and Purnell Acts, and \$250,200 appropriated for the Alaska and insular stations. In addition the office maintained close advisory relations with regard to all of the work of the stations, whether supported by Federal funds or by State and other funds, which now involves a total annual expenditure of about \$18,000,000 and deals with a wide range of agricultural research.

ADMINISTRATION OF FEDERAL ACTS APPROPRIATING FUNDS FOR THE EXPERIMENT STATIONS

The Federal acts were administered as usual on the basis of a program of projects and a budget of expenditures submitted to the office for consideration and approval at the beginning of the year, and a thorough examination of the work and expenditures of the stations during the year.

More than 400 Adams projects and 1,300 Purnell projects in active operation during the year were examined in detail as to progress and expenditures, with a view to making such revisions and adjustments as might be deemed necessary to secure the most effective use of the funds. Members of the office staff familiar with the personnel, facilities, and equipment of each of the stations and with the progress of investigation in the various fields passed on the merits of these projects. An examination was also made of the station work supported by Hatch and other funds. A representative of the office visited each of the stations during the year for the purpose of making

an examination of the accounts; consulting with the director of the station and leaders of the various projects; discussing matters of administration, policy, and personnel; inquiring into facilities for research and considering programs of work; and preparing a report on each station. An extensive correspondence relating to these matters was carried on. The Federal funds are being carefully safeguarded and, to an increasing extent, restricted to intensive and productive research.

A review of the work of the stations with discussion of questions of organization and policy and giving detailed statements of income and expenditures, additions to facilities and equipment for research, changes in personnel, and a classified list of publications was published in a Report on the Agricultural Experiment Stations, 1929, and a similar report for 1930 was submitted for publication.

Cooperation between the department and the stations made distinct progress during the year and now includes over 1,000 projects, or more than 15 per cent of the projects in which the stations are engaged. All the State stations and research bureaus of the department are taking part in this cooperation. Many of the projects are regional in scope and involve cooperation of a number of stations as well as bureaus of the department. A more uniform method of arranging cooperation between the bureaus and experiment stations and of recording cooperative projects has been established.

A study of cooperative relations between experiment stations and between stations or groups of stations and the Department of Agriculture, particularly in the field of economics, was made by B. Youngblood, who also continued as chairman of the cotton research coordination committee of the department and served in an advisory capacity with a similar committee of the Association of Southern Agricultural Workers.

INSULAR EXPERIMENT STATIONS

The work at the experiment stations maintained by the Department of Agriculture in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, under the administrative direction of Walter H. Evans, continued to be devoted to efforts to diversify agriculture and to develop new or better sources of agricultural income. While much pioneer work is necessary to determine the immediate problems and methods for their solution, each station is contributing fundamental data applicable to other regions similarly situated. Several of the publications of the stations have been reproduced by official or private agencies for distribution in other countries, and the number of inquiries from foreign countries as to phases of insular station work is increasing rapidly.

The regular appropriations for the stations for 1931 were: Alaska, \$85,300; Hawaii, \$45,200; Porto Rico, \$59,200; Guam, \$30,200; and the Virgin Islands, \$30,300. In addition the Virgin Islands station received by allotment from an appropriation for the temporary government of the West Indian Islands \$16,700, which was available for the station's use in expanding its work. The proceeds from the sale of products by the insular stations during the year amounted to \$4,796.55, which was deposited in the Treasury as miscellaneous receipts and was not available for station maintenance.

ALASKA STATIONS

The most important events connected with the Alaska experiment stations during the year were the transfer of the Fairbanks station to the Alaska College of Agriculture and School of Mines and the closing of the station on Kodiak Island.

By act of Congress approved February 23, 1929, the Hatch Act was provisionally extended to the Territory of Alaska, and the act making appropriations for this department for 1932, in addition to providing a small fund for the transferred station, authorized the Secretary of Agriculture to turn over to the College of Agriculture the lands, buildings, and such equipment as was not needed at the other experiment stations maintained in Alaska by this department. On May 1, 1931, the station was formally turned over to the president of the college by the director of the Alaska experiment stations. A small appropriation was made by the Territorial legislature to aid in carrying on the work of the station, and George W. Gasser, formerly connected with the experiment stations at Rampart and Fairbanks, was appointed director of the college station. F. E. Higgins, who had been in charge of the Fairbanks station for about three years, was transferred to the Matanuska station and placed in charge of the work in agronomy and plant breeding.

The Fairbanks station was established in 1907, and some preliminary land clearing was done that year. The equipment at the Copper Center station was transferred to Fairbanks in 1909, when the first experimental work was undertaken. For several years land clearing, fencing, and the erection of buildings took most of the allotted funds. It was not until 1912 that experimental work with crops was undertaken other than on small plats. With the closing of the Rampart station the cereal-breeding work was transferred to the Fairbanks station and considerably enlarged. The Fairbanks station has shown definitely the agricultural possibilities of large areas in the Tanana and Yukon Valleys, where the summers are short and where the average rainfall is about 12 inches.

The Kalsin Bay station on Kodiak Island was closed June 15, 1931, following a reduction in the appropriations that did not permit its further operation. Livestock work had been in progress on Kodiak Island since 1907, with the exception of the period from 1912 to 1914 following the eruption of Mount Katmai, when the pastures were destroyed. The principal problem was the winter management of stock, and it was demonstrated that cattle could be maintained on native pastures for about nine months a year and overwintered on hay or silage made from grass growing on tidal flats and other areas. It was found that cattle should be provided with some shelter against the cold winter storms when the rainfall is often very heavy.

With the transfer of the Fairbanks station and the closing of the Kodiak station, work carried on by the other stations maintained by this department will be centered at Matanuska and at Sitka. At the Sitka station the work will be mainly horticultural, as the topography and climate of southeastern Alaska are not suited to grain growing. At the Matanuska station agronomy, horticulture, livestock, and dairying will receive attention. This region is intermediate in climate between the dry interior and the wet coast region, and the station is located in an extensive area that is capable of considerable agricultural development.

At the Matanuska station the experiment on the production of a strain of hardy dairy cattle by crossing the Galloway and Holstein breeds is continuing satisfactorily. The station now has a number of second-generation cows that give more milk than the average of the Holstein herd. The hardiness of these crossbred animals has been demonstrated, and experiments are now in progress to fix the type so that breeding stock will be available to settlers. The yak-Galloway crossbreeding experiment is being continued. The small herd passed the winter on open range, and all the animals were in good condition in the spring, indicating their adaptability to the conditions prevailing in the interior of Alaska. The station is giving considerable attention to methods of curing hay in the region, where usually the latter part of the summer is cool and rainy.

The station is cooperating with the Alaska Railroad in land-settlement matters, in the management of a cooperative creamery, and in finding markets for settlers' produce. It is also cooperating with a number of Indian schools in dairying and in growing farm and garden crops.

The Sitka station is cooperating with many persons in southeastern Alaska on various problems relating to gardens and home ornamentation.

HAWAII STATION

The past year, the second under the plan of coordinating the work of the former Federal experiment station with that of the University of Hawaii, was characterized by substantial progress. Under the consolidation plan a wider field of activity has become possible, and there has been a marked increase in interest in the work. A newly established substation was located in the Kona district on the west coast of the island of Hawaii, and experiments with coffee and a large number of tropical fruit and nut-bearing plants have been started. On the island of Maui a tract of land was set aside by the governor for experiments at an elevation of 3,500 feet or more. Other tracts up to 6,400 feet in elevation were acquired and experiments begun with pigeon peas and other crops that appear promising for this region. If successful, more than 20,000 acres of waste land on Maui alone will be made productive. The work at the Makawao substation, at an elevation of 2,100 feet, has already demonstrated the practicability of growing pineapples at elevations of 1,000 feet or more higher than was previously thought possible. It has also established the value of numerous other crops for this region.

The station has in progress an extensive experiment with the pigeon pea, a valuable forage and green-manure plant that offers considerable possibilities for food purposes. Nearly 1,000 varieties, hybrids, and selections, including material from high altitudes in India, have been planted for cooperative studies. These plantings probably represent the most extensive collections of varieties and strains of this plant ever assembled. Experiments with forage crops continue to be an important part of the work of the station. Some of the more than 50 species of grasses under test have shown such promise that large demands are made on the station for planting material. Work with the edible canna as a commercial source of starch has been continued.

Experiments with cane molasses as feed for dairy cows, in progress for a number of years at the university, were continued by the sta-

tion, and the seventh year's results were obtained, indicating that somewhat less than 25 per cent of the carbohydrate ration can come from cane molasses.

The oil content of *Macadamia* nuts has been found to vary widely, and this information is being used in further selection and breeding with this promising new commercial crop. In studies on the utilization of surplus avocados a method for extraction of avocado oil has been perfected, and the bitter principle developed on heating the avocado has been isolated and identified. Further studies of the physicochemical properties of canna starch showed it to resemble potato starch most nearly, although there were some important differences that adapt canna starch for certain special uses.

Considerable attention was given to vitamin studies of locally produced food products such as Chinese cabbage, local oranges, rice bran, the shellfish apihi, and to the biological values of the proteins in the pigeon pea.

The horticultural work of the station was considerably extended through the acquisition of additional planting sites. Plantings have been made of many economic fruit, nut, and other trees to determine their adaptability to different elevations, soils, etc., and methods for their propagation are being investigated. The native raspberry, or akala berry, has been planted on the higher portion of the main station tract, and breeding experiments have been commenced to develop commercial forms adapted to the higher elevations of the islands.

Experiments on the control of sorehead, or fowl pox, of chickens have shown that mosquitoes are an important factor in spreading the disease among baby chicks. The advantages of rearing baby chicks in confined quarters in Hawaii have been satisfactorily demonstrated on an extensive scale.

PORTO RICO STATION

George F. Freeman, who was appointed director of the station on the retirement of D. W. May on April 22, 1930, died September 17, 1930. Doctor Freeman was succeeded as director by T. B. McClelland, who for more than 20 years has been in charge of the horticultural work of the station. The positions of research chemist, entomologist, and plant pathologist on the station staff are vacant but should be filled as soon as possible, since many important problems in these fields await investigation.

The Porto Rico station cooperated with the local authorities in the preparation of an exhibit at the International Colonial Exposition at Paris, as well as of an exhibit of Porto Rico products at Atlantic City, N. J., and the station's contributions were highly praised by the director of exhibits for Porto Rico.

Considerable attention was given to the improvement of the station property. Adequate drainage was provided for the lower part of the station farm, where cultivation was often impossible during the rainy season, and provision was made for irrigating this tract during the dry season. This has already proved of much value in connection with the crop work. The erection of a greenhouse to replace the one destroyed by the hurricane of September, 1928, was begun. This structure was badly needed to protect from torrential rains the plants used in breeding and propagation work.

The plant-breeding work with sugarcane and corn is giving some very important results. Of a number of cane seedlings under test for five years or longer four are proving especially promising. At several centrals where these seedling canes were tested cooperatively during the past year there are now about 300 acres planted to them that will be available for harvest in 1933. Comparative studies of the P. O. J. 2878, a recently introduced cane variety, and B. H. 10/12, one of the standard canes planted in Porto Rico, showed that in general P. O. J. 2878 surpassed in tonnage of cane, sucrose, and purity of juice, but that it is easily uprooted by strong winds. Crosses made between P. O. J. 2878 and Mayaguez 28 are highly resistant to mosaic, withstand drought very well, and are not easily blown over.

Much of the corn-breeding work is carried on in cooperation with the insular department of agriculture and with a number of planters. One hybrid yielded in the past year at the rate of 57.8 bushels per acre, a high yield for Porto Rico. Other promising hybrids are under observation and selections have been made from 95 inbred lines for further development. Additional hybrids were produced during the year.

In cooperation with citrus and pineapple growers a study was made of the root growth of citrus trees as related to stocks and soils, and important data were obtained on root distribution as related to cultivation, the application of fertilizers, leaching, and soil type. Neither root pruning nor applications of calcium phosphate was found to influence the time of blooming of pineapples. In a study of bay-oil production it was found that fuchsine applied to the leaves of the bay tree was a rapid and efficient method of determining types of trees that produce the undesirable lemon-scented leaves.

Studies of internal and external parasites of domestic animals were continued. Definite information was secured to show that the water beetle, *Tropisternus collaris*, is an intermediate host for the thorny-headed worm, *Macracanthorhynchus hirudinaceus*, of swine. An unusually dry season afforded an opportunity to study the effect of drought on liver-fluke infestation of calves. In spite of the prolonged drought and the drainage of infested areas, which were expected to reduce the snail population, fluke infection followed. This is believed to indicate that under natural conditions the encysted stage of the parasite found on grass is resistant to drought and remains infective for several months.

On March 4, 1931, Congress extended to Porto Rico in a modified form the Hatch, Adams, and Purnell Acts, and the first appropriation is authorized for the fiscal year 1933. The act provides that the experiment station established shall be conducted jointly and in collaboration with the existing Federal experiment station in Porto Rico, and that the Secretary of Agriculture shall coordinate in the island the work of the Territorial station with that of the Federal station and of the United States Department of Agriculture. Preliminary negotiations have been begun to effect the results implied by the legislation.

GUAM STATION

The Guam station continued its efforts to bring about a diversification of the agriculture of the island, and commendable progress

was made, considering the limited personnel and equipment of the station.

During the year the director of the station visited the mainland of the United States to confer with department and experiment-station officials and returned with a considerable quantity of plant and seed material for testing under Guam conditions. The entomologist made a short trip to Japan in connection with the introduction of corn-borer parasites and later visited California.

Through the cooperation of the Bureaus of Animal Industry and Dairy Industry valuable additions were made to the station herds and flocks. The Navy Department cooperated in this introduction of breeding stock by transporting the animals from the east coast of the United States to the station in Guam. In connection with these introductions shipping data were secured that will be of value to those contemplating further importations. The work of the station in the improvement of the livestock of the island has stimulated a few livestock raisers to make importations of their own. The station now has creditable herds of Ayrshire cattle, Duroc-Jersey hogs, and flocks of Rhode Island Red and White Leghorn chickens. In addition, it has a Shorthorn bull for breeding for beef type of cattle.

The experimental work of the station has been developed as rapidly as possible. Further feeding trials have shown the value of adding coconut meal to the ration of all kinds of livestock. Being locally produced it is a cheap feed material, and its use is being adopted rapidly by the people of the island.

The station's efforts to produce a hardy race of chickens by crossing Rhode Island Red, White Leghorn, and native stock has resulted in a strain that is well adapted to local conditions, and this grade stock is in much demand by the farmers of the island.

On account of the low price of copra, the most important agricultural product of the island, the station has endeavored to find other cash crops for exportation and local consumption. Success with trial shipments of avocados to Manila indicate the possibility of developing a limited market for good varieties of this and other fruits. Studies are in progress on the feasibility of producing for exportation to the United States some special crops which are sources of drugs, insecticides, etc.

The station cooperated with the Bureau of Entomology of this department on the introduction and breeding of parasites of the corn borer and gave particular attention to the distribution of housefly parasites, to watching the coconut-scale situation, and to the control of plant pests in general. The coconut-scale situation continues favorable, a biological balance apparently having been established between the scale and its predatory and parasitic enemies.

The extension work of the station, which was reestablished under an assistant extension agent a little over a year ago, has made commendable progress. Adult demonstrations of the results of station work are made by field men, a method of approach which has been found essential to success. The work with boys' and girls' clubs expanded rapidly. At the end of the year 1,025 boys and girls, or practically one-third of the school population of the island, had been enrolled in corn, bean, root-crop, rice, copra, poultry, and pig clubs. The club work is generally admitted to be the most promising method of permanently improving the agriculture of the island.

VIRGIN ISLANDS STATION

Following a survey of the Virgin Islands made in 1930 by the Chief of the Bureau of Efficiency, at the request of the House Subcommittee on Naval Appropriations, a radical change was made in the local affairs of the islands, and a civilian government was substituted for the naval government which had been in charge of the islands since they were acquired in 1917. Appropriations were made for the temporary government of the islands, and a considerable sum was allotted to the experiment station for expanding its work.

J. B. Thompson, for nearly 10 years director of the station, was transferred to work carried on by the Bureau of Plant Industry and by the Bureau of Animal Industry at Jeanerette, La. He was succeeded on March 1, 1931, by J. R. Ricks, formerly director of the Mississippi Agricultural Experiment Station. Maybin S. Baker, for about six years agronomist of the station, resigned in November, 1930, to accept a position with a large sugar plantation in Porto Rico. Following the reorganization of the station, Helen L. Cawley was appointed home demonstration agent; N. N. Nichols was appointed associate animal husbandman and dairyman; Glen Briggs, formerly of the Guam and Oklahoma Experiment Stations, was appointed agronomist; and D. S. Blackwood was appointed farm superintendent.

Economic conditions in the Virgin Islands had been unsatisfactory for some time, and a crisis was reached on St. Croix in 1929 when, following a prolonged drought which greatly reduced the sugar crop, all the cane mills were closed and a large number of workers were thrown out of employment. The situation was so serious that at the request of the Chief of the Bureau of Efficiency and local authorities the station suspended some of its usual activities and devoted its energies to encouraging the people to plant and cultivate gardens as a relief measure. Several hundred gardens were planted and tended by people out of employment, and the considerable quantity of vegetables produced aided materially in relieving the distress.

For a number of years the production of sea-island cotton was profitable in St. Croix, but the advent of the pink bollworm and the low price of cotton resulted in its abandonment. In order to determine whether the industry could be restored, U. C. Loftin, of the Bureau of Entomology, made a survey of the situation, and, based on his findings, a campaign for the destruction of all wild host plants of the insect was begun. It is hoped that this, together with closed seasons, when all cotton plants are destroyed, will result in reestablishing the growing of cotton, a crop which seems especially adapted to small holdings.

Activities undertaken to restore some former agricultural industries included a survey of the bay-oil industry by W. W. Skinner, of the Bureau of Chemistry and Soils; and plans are being made for investigations designed to improve bay-oil production, an industry in which the Virgin Islands formerly led.

A reconnoissance soil survey of St. Croix was made by J. T. Thorpe, of the Bureau of Chemistry and Soils, and the principal soil types were mapped for further work.

The station is gradually getting back to its normal activities. The work with introductions and hybrids and selections of tropical field and horticultural crops is being developed as rapidly as pos-

sible. Special attention is being given to study of root stocks for orange and grapefruit trees to find suitable stocks that are adapted to the principal soil types of the islands.

The veterinarian and animal husbandman of the station continued his efforts to improve the livestock of the islands and to reduce losses through the control of diseases. During the year, through the cooperation of the Bureau of Animal Industry, two shipments of improved horse, cattle, sheep, goat, and swine sires were received and made available for upbreeding the local herds and flocks. The veterinarian also acts as quarantine inspection officer for all livestock introduced into, or shipped from, the Virgin Islands.

The work of the home demonstration agent, which was begun in March, 1931, has been organized to include studies of food and nutrition, school lunches, women's clubs, 4-H clubs, and studies of village groups to improve their condition.

The extension and demonstration work on the islands of St. Thomas and St. John is proceeding as formerly. These islands are for the most part hilly and rugged, making cultivation difficult. The demonstration agent is endeavoring to find new varieties of fruits and vegetables adapted to such conditions, profitable ways of marketing the crops, and new uses for surplus products. Considerable attention has also been given to poultry and livestock work. During a protracted drought a concrete silo was constructed and filled with guinea grass for silage, but this was not needed, as rains replenished the pastures. In an attempt to utilize native fruits an experiment was undertaken in the canning of the native soursop. Samples of the canned product were favorably received in New York and other markets. The canned product is said to make excellent ices and cooling drinks.

EXPERIMENT STATION RECORD

The Experiment Station Record, under the editorship of H. L. Knight, continued to be maintained as an integral part of the activities of the office in encouraging and assisting in the progress of agricultural research. Volumes 63 and 64 were brought to completion within the year, each volume, as usual, comprising 9 numbers of 100 pages each. Fully 93 per cent of this space was devoted to abstracts of the world's current literature pertaining to agricultural science, the remainder being utilized for editorial discussions each month of significant developments in agricultural education and research and brief notes in each issue on current progress along these lines. In addition, the customary index number of about 100 pages was prepared for each volume.

The editorial policy of the Record was maintained without substantial change other than a slight curtailment of space devoted to editorials, in consequence of the steadily increasing congestion of abstracts awaiting publication. Among the matters discussed editorially were the survey of the land-grant colleges and universities by the United States Office of Education, the fiftieth anniversary celebration of the New Jersey State Experiment Station, the International Conference of Agricultural Economists at Cornell University, the Inter-American Conference on Agriculture, Forestry, and Animal Industry, the 1930 convention of the Association of Land-Grant Colleges and Universities, vocational education in agriculture from the standpoint of labor, recent historical treatises on entomol-

ogy, and international cooperation in agro-ecological investigations. This feature of the Record is one of long standing and has been found exceedingly useful as a medium for the periodic discussion of the problems and needs of the experiment stations.

As its name implies, the distinctive function of the Experiment Station Record is to present an epitome of the results obtained by the experiment stations in this country and by the United States Department of Agriculture. These results are embodied in publications issued by over 50 widely scattered institutions at irregular intervals and are regarded by librarians and others as exceptionally difficult to keep track of. During the past year the Record published abstracts of 925 publications of the stations and 373 from the department, using a system of assignment whereby each was abstracted as completely and expeditiously as possible, and the abstracts were assembled for publication substantially on a chronological basis. In this way the results of station and department research were made available promptly and systematically all over the world.

In recent years the quantity and importance of this published work of the stations and the department have greatly increased, and the policy of giving precedence to the abstracts of this material has resulted in its absorption of more and more of the space in the Record. This has unfortunately resulted in a corresponding reduction in the space available for abstracts from other sources. The total space limit of 1,800 printed pages per year was established in 1911. Since that time the aggregate annual income of the experiment stations in this country has increased from less than \$4,000,000 to over \$18,000,000, and their scientific staffs have practically doubled. Their output in publications has increased proportionately, partly in the stations' own series but even more largely through scientific journals. Other research agencies in the field of agriculture have shown a similar increase in activity, and such subjects as agricultural economics, rural sociology, agricultural engineering, and home economics (especially textiles, clothing, and home management) have made practically their entire development during this period. Under these circumstances the problem of keeping abreast of the ever-growing flood of literature becomes more acute each year, and although a total of 5,606 abstracts appeared in the current volumes, the completeness of the review in certain fields, especially in the newer lines of inquiry, necessarily fell short of what could have been obtained under more favorable circumstances.

Notwithstanding these handicaps, there are many evidences that the Record occupies a unique field of usefulness. It is the only agency that has ever attempted to abstract the publications of the experiment stations and the department in a systematic and comprehensive way, and since its scope is restricted to the fields of agriculture and home economics, it is enabled to present this material with relative completeness but in a compact and undiluted form which is of great convenience to many users. The Record has proved especially helpful as a reference aid in the many specialized phases of research in agricultural science, in college and agricultural high-school instruction, and to county agents and others engaged in extension teaching and commercial work. The demand from these various sources has continued steadily to increase despite closer restrictions upon the free distribution.

A special achievement of the year was the publication of a fourth combined index, covering volumes 41 to 50 and the period 1919-1924. Although the edition was not sufficient to permit of the free distribution of the index to individuals, it was made widely available through libraries, and the needs of research institutions and similar agencies were largely taken care of. This index contains over 80,000 individual entries, which indicates the comprehensiveness of the field which the Record covers and the practical service it renders. Substantial progress was also made in the preparation of a similar index covering volumes 51 to 60 (1925-1929).

The cooperative arrangement by which copies of abstracts of department and experiment-station publications prepared for the Record were supplied to F. V. Rand, the department representative of Biological Abstracts, was continued.

OTHER ACTIVITIES OF THE OFFICE

Meetings, conferences, service on committees, and preparation of special reports and papers and exhibit material relating to the work of the office and the experiment stations continued to demand much time and attention from members of the staff.

Relations with the Association of Land-Grant Colleges and Universities included especially service on the committees on experiment-station organization and policy, projects and correlation of research, and vitamin content of food in relation to human nutrition, and presentation of papers at the annual convention of the association in November, 1930, on The First Five Years of the Purnell Act, by Walter H. Evans; Agricultural Engineering Research and Engineering Experiment Stations, by R. W. Trullinger; and Organization of a Program of Research [in Home Economics], by Sybil L. Smith. Members of the staff also attended and took part in meetings of the Association of Southern Agricultural Workers, Conference of North-eastern States Directors, American Society of Agronomy, American Soil Survey Association, American Library Association, American Association of Agricultural College Editors, American Society of Agricultural Engineers, American Engineering Council, American Society of Animal Production, American Farm Economic Association, Association of Official Agricultural Chemists, American Home Economics Association, Federated Biological Societies, Canadian Society of Technical Agriculturists, International Conference of Agricultural Economists, and Inter-American Conference on Agriculture, Forestry, and Animal Industry.

Exhibit material relating to the work of the office and the experiment stations was prepared for the Chicago World's Fair Centennial Celebration (A Century of Progress) in 1933, the World's Grain Exhibition and Conference at Regina, Saskatchewan, the Inter-American Conference on Agriculture, Forestry, and Animal Industry held in Washington in September, 1930, and the French Colonial Exposition in Paris in 1931.

Members of the staff held numerous conferences with specialists of the experiment stations and of the bureaus of the department, with representatives of commercial organizations interested in agricultural research, and with foreign scientists planning to visit the experiment stations.

PUBLICATIONS

There was a material increase in the volume of publications of the office during the year, including 38 documents aggregating 3,773 pages, as compared with 36 documents aggregating 2,789 pages in the preceding year. The publications dealt, as heretofore, primarily with organization, administration, and progress of research at the State experiment stations and at the stations maintained by the department in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, giving information regarding income and expenditures, personnel, facilities for research, projects, publications, and results of the work.

In addition to the Experiment Station Record and reports previously referred to, a 252-page classified list of the 7,000 or more station projects and a revised list of station personnel, now numbering about 3,500, were published. Reports, bulletins, and circulars dealing with the work of the Alaska and insular stations were published by the office as heretofore. Articles were contributed to the 1931 Yearbook of the department as follows: Breeding Studies at Experiment Stations Show Genetic Factors, by George Haines; and Experiment Station Record Keeps Track of What is New in Research, by Howard Lawton Knight. Members of the staff also contributed a number of articles to outside periodicals and proceedings of various organizations.

A History of Agricultural Experimentation and Research in the United States, 1620-1925, including a History of the United States Department of Agriculture, being the third of the series of historical monographs on agricultural education and research in the United States prepared by the late A. C. True, was edited and submitted for publication.

LIBRARY

The library serving both the Office of Experiment Stations and the Office of Cooperative Extension Work continued as in previous years in charge of Cora L. Feldkamp. There was an increased demand for reference work, and lists of references were prepared on agricultural credit, extension studies, forage grasses, fur, hides and leather, rugs, basketry and leather work, preservation of meat and use of the products, and bacteriology, chemistry, and nutritive value of milk.

The library maintained its file of station publications and prepared lists of accessions for publication. Continuing its catalogue of articles by station workers published in technical and scientific journals, the library recorded 1,717 such articles appearing in 69 journals, exclusive of 64 articles contributed or collaborated in by 26 stations which appeared in the Journal of Agricultural Research.

The librarian presented a paper entitled "A Librarian Looks at Our Publications" at the Washington meeting of the American Association of Agricultural College Editors and took part in discussions of questions regarding the importance and adequacy of the library service of the experiment stations at the New Haven meeting of the American Library Association.

UNITED STATES DEPARTMENT OF AGRICULTURE
EXTENSION SERVICE

WASHINGTON, D. C.

ISSUED, MAY, 1932

Report of
Extension Work
in
Agriculture and Home Economics
in the United States
1931



This report supersedes the annual reports entitled "Report of the Director of the Extension Service" last issued for the fiscal year 1930, and "Cooperative Extension Work" last issued for the calendar year 1929

DEPARTMENT OFFICIALS IN CHARGE OF COOPERATIVE EXTENSION WORK

EXTENSION SERVICE

C. W. WARBURTON, Director

C. B. SMITH, Assistant Director

STATE DIRECTORS IN CHARGE OF COOPERATIVE EXTENSION WORK¹

- ALABAMA.—L. N. Duncan, Alabama Polytechnic Institute, Auburn.
ARIZONA.—P. H. Ross, College of Agriculture, University of Arizona, Tucson.
ARKANSAS.—(Dan T. Gray, director, College of Agriculture, University of Arkansas, Fayetteville.
T. R. Reid, assistant director, 310 Federal Bank and Trust Building, Little Rock.
CALIFORNIA.—B. H. Crocheron, College of Agriculture, University of California, Berkeley.
COLORADO.—F. A. Anderson, director, State Agricultural College of Colorado, Fort Collins.
CONNECTICUT.—B. W. Ellis, Connecticut Agricultural College, Storrs.
DELAWARE.—C. A. McCue, University of Delaware, Newark.
FLORIDA.—Wilmon Newell, Agricultural Extension Service, Experiment Station, Gainesville.
GEORGIA.—J. Phil Campbell, Georgia State College of Agriculture, Athens.
HAWAII.—F. G. Krauss, University of Hawaii, Honolulu.
IDAHO.—E. J. Iddings, College of Agriculture, University of Idaho, Moscow.
ILLINOIS.—H. W. Mumford, College of Agriculture, University of Illinois, Urbana.
INDIANA.—J. H. Skinner, Purdue University, La Fayette.
IOWA.—R. K. Bliss, Iowa State College of Agriculture and Mechanic Arts, Ames.
KANSAS.—H. J. C. Umberger, Kansas State College of Agriculture and Applied Science, Manhattan.
KENTUCKY.—T. P. Cooper, College of Agriculture, University of Kentucky, Lexington.
LOUISIANA.—J. W. Bateman, Louisiana State University and Agricultural and Mechanical College, University Station, Baton Rouge.
MAINE.—A. L. Deering, College of Agriculture, University of Maine, Orono.
MARYLAND.—T. B. Symons, University of Maryland, College Park.
MASSACHUSETTS.—W. A. Munson, Massachusetts Agricultural College, Amherst.
MICHIGAN.—R. J. Baldwin, Michigan State College, East Lansing.
MINNESOTA.—F. W. Peck, Department of Agriculture of the University of Minnesota, University Farm, St. Paul.
MISSISSIPPI.—L. A. Olson, Mississippi State College, State College.
MISSOURI.—R. R. Thomasson, acting director, College of Agriculture, University of Missouri, Columbia.
MONTANA.—J. C. Taylor, Montana State College of Agriculture and Mechanic Arts, Bozeman.
NEBRASKA.—W. H. Brokaw, College of Agriculture, University of Nebraska, Lincoln.
NEVADA.—C. W. Creel, College of Agriculture, University of Nevada, Reno.
NEW HAMPSHIRE.—J. C. Kendall, University of New Hampshire, Durham.
NEW JERSEY.—H. J. Baker, College of Agriculture and Mechanic Arts of Rutgers University (State University of New Jersey), New Brunswick.
NEW MEXICO.—W. L. Elser, New Mexico College of Agriculture and Mechanic Arts, State College.
NEW YORK.—C. E. Ladd, New York State College of Agriculture, Ithaca.
NORTH CAROLINA.—I. O. Schaub, State College Station, Raleigh.
NORTH DAKOTA.—C. F. Monroe, North Dakota Agricultural College, State College Station, Fargo.
OHIO.—H. C. Ramsower, College of Agriculture, Ohio State University, Columbus.
OKLAHOMA.—D. P. Trent, Oklahoma Agricultural and Mechanical College, Stillwater.
OREGON.—P. V. Maris, Oregon Agricultural College, Corvallis.
PENNSYLVANIA.—M. S. McDowell, Pennsylvania State College, State College.
RHODE ISLAND.—George E. Adams, Rhode Island State College, Kingston.
SOUTH CAROLINA.—W. W. Long, Clemson Agricultural College of South Carolina, Clemson College.
SOUTH DAKOTA.—Dean C. Larsen, South Dakota State College of Agriculture and Mechanic Arts, Brookings.
TENNESSEE.—C. A. Keffner, College of Agriculture, University of Tennessee, Knoxville.
TEXAS.—O. B. Martin, Agricultural and Mechanical College of Texas, College Station.
UTAH.—William Peterson, Agricultural College of Utah, Logan.
VERMONT.—J. E. Carrigan, acting director, University of Vermont and State Agricultural College, Burlington.
VIRGINIA.—J. R. Hutcheson, Virginia Polytechnic Institute, Blacksburg.
WASHINGTON.—F. E. Balmer, director, State College of Washington, Pullman.
WEST VIRGINIA.—N. T. Frame, College of Agriculture, West Virginia University, Morgantown.
WISCONSIN.—(C. L. Christensen, director, } College of Agriculture, University of Wisconsin, Madison.
(E. L. Hatch, associate director, }
WYOMING.—A. E. Bowman, College of Agriculture, University of Wyoming, Laramie.

¹ Revised to Apr. 15, 1932.

REPORT OF EXTENSION WORK IN AGRICULTURE AND HOME ECONOMICS IN THE UNITED STATES, 1931¹

Prepared by the Extension Service

C. W. WARBURTON, Director

C. B. SMITH, Assistant Director

This report supersedes the annual reports entitled "Report of the Director of the Extension Service" last issued for the fiscal year 1930, and "Cooperative Extension Work" last issued for the calendar year 1929.

CONTENTS

	Page		Page
Introduction.....	1	Cooperative extension work—Continued	
Drought emergency met.....	2	Home demonstration work.....	22
Production adjustment sought.....	3	Boys' and girls' 4-H club work.....	37
Funds administered.....	4	Extension work with negroes.....	43
Personnel.....	4	Farmers' institutes.....	53
Economics extension expansion.....	4	Specialists' activities.....	55
Agricultural improvement programs.....	4	Extension in agricultural economics.....	70
4-H club development.....	5	Extension studies and teaching.....	74
Land utilization.....	5	Information and visual instruction.....	77
Teaching methods improved.....	6	Exhibits.....	80
Extension Service Review.....	6	Cooperation with fairs.....	82
Talking-picture production.....	7	Preparation of exhibit.....	83
Cooperative extension work.....	7	Funds and personnel.....	84
Personnel.....	7	Motion pictures.....	85
Special developments.....	9	Appendix.....	87
County agricultural agent work.....	12		

INTRODUCTION

During 1930 an emergency existed in practically all agricultural regions of the United States. In meeting this emergency, the extension forces of the State agricultural colleges and the department played no uncertain part. Over large areas the situation was so urgent that it was necessary for extension workers to lay aside temporarily much of their regular programs and devote the major part of their time to initiating and directing measures designed to help farmers relieve the distressing conditions.

Already made difficult by world-wide economic depression, unfavorable markets, and the existence of surplus stocks of some of the

¹ Funds for extension work are appropriated for fiscal years ending on June 30, whereas extension agents prepare their reports for calendar years. For this reason statements of funds expended are given for the fiscal year ended June 30, 1930, and results of work done for the calendar year ended Nov. 30, 1930.

NOTE.—Extension work in agriculture and home economics, authorized by the Smith-Lever Act of May 8, 1914, is carried on cooperatively by the U. S. Department of Agriculture and the State agricultural colleges. This report was written and printed in accordance with a provision of the act of Congress of Mar. 4, 1915, entitled "An act making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1916." (38 Stat. L., p. 1110.)

major farm commodities, particularly wheat and cotton, the situation of the farmers was further complicated by the most severe drought recorded by the Weather Bureau. The drought caused its greatest damage in a region extending roughly from the Atlantic coast of Maryland and Virginia westward to Oklahoma and Texas. Severe drought damage also occurred in several Northwestern States. Production of most farm crops was greatly reduced in these regions. Instead of being followed by the increased values usually resulting from crop shortages, the reduced farm production was accompanied toward the end of the season by a drop in farm commodity prices to the lowest point in 15 years. The decline in prices affected farmers in practically all sections of the country. This unusual combination of adverse conditions caused much economic loss and suffering to thousands of farm families.

DROUGHT EMERGENCY MET

Not only was the farm income considerably curtailed during the year by drought conditions and low prices, but the reduced production made it impossible in drought-affected areas to store a sufficient amount of food for home consumption. The important problem therefore was to provide farming people with an adequate food supply for the winter. Low cash and food resources on the farms seriously hindered the efforts of extension agents to advise farm families about cheap, wholesome foods which would maintain health and particularly would prevent such diseases as pellagra, caused by inadequate diet. Nevertheless these efforts were made, and the cooperation of food manufacturers and dealers in insuring availability of needed foods at the lowest possible cost, was obtained.

Farm men and women were urged to plant fall gardens of rapidly maturing vegetables, to can all available food products, and to preserve eggs for winter use. Demonstrations in canning poultry and beef showed farm people how to provide a supply of meat for the winter. It was pointed out that slaughtering farm animals and canning the meat relieved farmers from the necessity of purchasing feed for the animals or selling them at the prevailing low prices. In an effort to relieve the impending shortage of clothing during the winter home demonstration agents and local leaders taught farm women how to renovate and remodel their garments. Extension agents also cooperated closely with representatives of the Red Cross by indicating the farm families who were particularly destitute and in need of urgent help in procuring food and clothing.

Farmers were advised on emergency rations for their livestock; were shown how to cull their herds and flocks; and were urged to plant forage crops for fall and spring pasture. Extension workers assisted in locating needed supplies of feed and forage and worked out plans for bringing in feedstuffs at the lowest possible cost. The railroads granted reduction in freight rates on hay, feed, and water shipped into the drought areas and on livestock shipped out from August 14 to November 30. County agricultural agents aided farmers to obtain the reduced rates. They approved applications for lower rates on approximately 60,000 carloads of hay, feed, and livestock at an estimated saving to the farmers of several million dollars.

A comparatively small balance remained from an appropriation made by Congress in March, 1930, for loans to farmers for the purchase of seed and fertilizer. This balance was immediately made available to finance the sowing of fall-pasture crops in Alabama, Missouri, Oklahoma, and Virginia. Restrictions in the act did not permit the money to be lent to farmers in other States. A joint resolution of Congress approved on December 20, 1930, provided \$45,000,000 for loans to farmers in the drought, storm, or hail-stricken regions for buying seed, fertilizer, feed, and fuel and oil for tractors. These funds brought definite financial aid to farmers in the drought region who needed assistance in producing crops during the 1931 season. Extension agents informed farmers where to apply for the loans and how to comply with the necessary requirements for obtaining them.

PRODUCTION ADJUSTMENT SOUGHT

Extension agents throughout the country were active in advising farmers about the Federal Farm Board program for establishing national commodity cooperative-marketing agencies through which local, State, and regional cooperatives might function more effectively. Although the formation of cooperative-marketing associations is a part of the long-time program to help farmers put their operations on a more profitable basis, work of this nature was of considerable help during the emergency.

Industrial depression, causing a declining demand for cotton and wheat, accompanied by an expanding production of these money crops, was responsible for the accumulation of large surplus stocks. The result was that the cotton and wheat States were faced with the necessity of selling their cash crops in many cases at prices below the cost of producing them. The efforts of the Farm Board to relieve the situation by adjusting the production of these commodities to more nearly meet the potential requirements of consumers were vigorously supported by extension agents. Information about market conditions, probable future demand, and other economic facts was supplied to farmers, who were thus enabled to plan their farm operations with a more intelligent understanding of domestic and world economic conditions. Methods of lowering production costs, of improving the quality of crops grown, and of handling and grading crops were emphasized.

Farmers in the wheat area were encouraged not to depend on wheat as a major source of income on farms where soil and topography did not permit low costs of production; to grow a sufficient acreage to permit economical use of modern machinery, power, and the farm labor supply; to conserve rainfall by terracing; to adopt a program of soil improvement embracing crop rotation, use of legumes, and raising of livestock; and to add supplementary farm enterprises, such as beef cattle, dairy cattle, or poultry production where they are profitable in connection with wheat farming. In the Southern States, extension workers made a thorough study to determine on what phases to concentrate during the emergency. Most Southern States decided to emphasize adoption of the system of balanced agriculture known in the South as the safe-farming pro-

gram. In urging this program, extension workers encouraged farmers to plant enough food and feed crops to supply their own needs before undertaking to plant cotton. They also advised the farmers to plant cotton only on land that had produced an average of more than one-third of a bale per acre during the last five years.

FUNDS ADMINISTERED

Federal appropriations amounting to \$6,192,936 were allotted to the 48 States and the Territories of Hawaii and Alaska for extension work under the terms of the Smith-Lever appropriation acts, and \$1,480,000 was allotted under the terms of the Capper-Ketcham Act. Congress made a special appropriation of \$1,000,000 for allotment to the States primarily for extension work in economics and marketing. The direct Federal appropriation for extension work was \$1,755,000, of which \$1,550,000 was for farmers' cooperative demonstration work and motion pictures, \$15,000 for general administrative expenses, \$120,000 for exhibits, and \$70,000 for farm forestry extension. The States, counties, and other agencies contributed \$15,876,250 for cooperative extension work. The total of all these items available for cooperative extension work with the State agricultural colleges and for motion pictures and exhibits was \$26,304,186.

PERSONNEL

The field force engaged in extension work in agriculture and home economics on June 30, 1931, consisted of 6,179 persons. The personnel of the department Extension Service in Washington consisted of 192 persons, of whom 7 were employed in the office of the director, 136 in the office of cooperative extension work, 26 in the office of exhibits, and 23 in the office of motion pictures. In addition, 10 subject-matter extension specialists were employed by other bureaus of the department in cooperation with the Extension Service.

ECONOMICS EXTENSION EXPANSION

The realization by the Extension Service that the problems faced by agriculture at present are largely economic led to a material expansion in economics extension personnel. During the year the States added 84 specialists to their forces, making a total of 204 full and part-time workers in this field. To meet the greatly enlarged demands from the field, the personnel in the department was increased and the economics extension work in marketing, farm management, outlook, and other lines was coordinated by establishing, in cooperation with the Bureau of Agricultural Economics, an economics extension unit in the office of cooperative extension work.

AGRICULTURAL IMPROVEMENT PROGRAMS

During the year county extension agents and specialists made material progress in developing programs for agricultural improvement. This type of program was variously called adjustment programs, long-time programs, economic programs, or farm-and-home programs. Local leaders, extension agents, and specialists in many

States came together, studied the farm situation, and agreed upon desirable adjustments in enterprises, farm organizations, and farm management that the farmers should make over a period of years in order to increase their incomes. The extension program for the current year was then developed on the basis of the adjustments agreed on. The adjustment program was based on searching study of local situations and needs as well as on general farm-management and market data. The information on local practices, trends, and needs was gathered in the following fields: Local farm business organization and farm-management systems which show the larger income returns; labor efficiency and price and cost data which affect enterprise and farm profits; economic factors which are affecting or may affect farm enterprises and organization, such as market situations and trends, transportation, influence of competing areas, and changes and trends in demand and production; and practices which are the most efficient and economical in carrying out proposed adjustments.

The adjustment program, whatever its type may be, is one of the great advances in extension work. It causes local needs and situations to be really studied by the people and the extension agents. Better incomes and standards of life and not merely the adoption of certain skills and improved production practices are its objectives. Under such a program specialists coordinate their efforts in solving the larger problems instead of offering projects in competition with one another. It allows the county agent to concentrate on the big problems which affect country life and does not diffuse his energy over a great miscellany of projects, demonstrations, and activities. Under it the people join in attacking a common problem instead of thinking of individual service. This plan has done much to systematize and spread the extension work in the counties and to improve the efficiency of extension workers.

4-H CLUB DEVELOPMENT

The 4-H club work continued its consistent growth during 1930, the enrollment for the year being 822,714 boys and girls as compared with that of 756,096 in 1929. Much credit for the results accomplished by 4-H club members in 1930 must be given to the 85,000 local club leaders who enlisted in the movement. (Fig. 1.) Beneficial effects of the Capper-Ketcham appropriation to increase the part-time personnel who give time to 4-H club work were evident both in the increased enrollment and in the increased percentage of club members completing the full requirements of their work. This increase was 9.23 per cent greater in 1930 than in 1929.

LAND UTILIZATION

Problems of land utilization are becoming important in many States and are leading to a closer coordination between forestry extension work and efforts for improved agricultural production along other lines. A definite policy in the use of marginal and submarginal lands is in formation. Unquestionably there will be marked developments in this field in the near future.

TEACHING METHODS IMPROVED

Extension teaching methods took more definite form during the year. County extension agents and specialists made more effort to obtain local data as a basis on which instruction might be made more definite and practical. There was also a distinct advance in the utilization of various information mediums, such as circular letters, news stories, printed bulletins and leaflets, and film strips. State extension specialists and county extension agents used localized film strips much more extensively than in previous years.



FIGURE 1.—A 4-H club boy in his garden

EXTENSION SERVICE REVIEW

During 1930 the Extension Service began the publication of a printed house organ entitled "Extension Service Review" for extension workers in agriculture and home economics. This publication brings to the attention of all extension workers the results obtained in various phases of extension activity and the teaching methods employed. Space is provided in it for discussion of various problems and policies affecting the progress of extension work. Through this publication extension agents are advised of the service available from the department, the Federal Farm Board, and other governmental agencies. Establishment of this publication is regarded as a distinct forward step in the effort of the Extension Service to keep its field force advised of the many developments in extension teaching and of trends in agriculture and home making that affect the character of extension activities.

TALKING-PICTURE PRODUCTION

After a lengthy study of the motion-picture situation and consideration of the factors in production of talking pictures, the Extension Service installed equipment for talking-picture production in its motion-picture studio. Three talking pictures had been produced by the end of the fiscal year.

COOPERATIVE EXTENSION WORK

PERSONNEL

There were 6,161 persons employed June 30, 1931, on the field staff of the Extension Service in the 48 States and the Territories of Hawaii, Alaska, and Porto Rico, an increase of 219 during the year. Of this number 4,444 were located in the counties. This group included 2,382 white county agricultural agents, 234 assistant county agricultural agents, 167 negro county agents, 1,241 white county home demonstration agents, 10 urban home demonstration agents, 36 assistant home demonstration agents, 123 negro home demonstration agents, 218 county boys' and girls' club agents, and 33 assistant county boys' and girls' club agents. There were 1,222 subject-matter specialists, usually with headquarters at the State agricultural colleges and 495 supervisors and administrative officers.

The new workers added during the year included 28 white county agricultural agents and 8 assistants, 79 white county home demonstration agents, 2 county boys' and girls' club agents and 2 assistants, 7 administrative and supervisory workers, and 122 subject-matter specialists. The number of negro county agents was reduced by 8, urban home demonstration agents by 2, assistant home demonstration agents by 15, and negro home demonstration agents by 4.

During the year the economics extension workers, employed in cooperation with the Bureau of Agricultural Economics, were grouped in a single unit, with H. M. Dixon as chairman. Through the cooperation of the New York State College of Agriculture of Cornell University, C. E. Ladd and M. C. Bond rendered helpful service in the organization of economics extension work in the States. Similar service was given by C. R. Arnold through the cooperation of the College of Agriculture of the Ohio State University. D. W. Watkins, who had served as assistant director of extension work in South Carolina for the last 12 years, was appointed extension economist on March 23, 1931.

In cooperation with the Bureau of Agricultural Economics and the agricultural colleges of Idaho, Montana, and Washington, H. E. Drobish was employed September 15, 1930, to conduct economics extension work on potatoes in the Pacific Northwest. This work is similar to that which has been carried on during the last two years in the early-potato producing areas of the Southeast.

Economics extension work in tobacco growing was carried on during the year in Virginia, North Carolina, South Carolina, and Georgia in cooperation with the agricultural colleges of those States and the Bureau of Agricultural Economics. R. M. Cooper was ap-

pointed November 1, 1930, to lead this work. It was discontinued June 30, 1931, however, because of the inability of several of the colleges to continue financial cooperation.

In cooperation with the Bureau of Animal Industry, E. M. Nighbert was employed November 5, 1930, to carry on extension work in animal parasite control.

Three extension specialists in economic entomology, F. D. Butcher, M. P. Jones, and P. D. Sanders, were appointed during the year in cooperation with the Bureau of Entomology.

In cooperation with the Division of Agricultural Engineering of the Bureau of Public Roads, S. P. Lyle was employed October 1, 1930, to conduct extension work in agricultural engineering.

Dairy extension work suffered a severe loss in the death on May 18, 1931, of J. H. McClain, extension dairyman for the Southern States.

Cooperative extension work in the Territory of Alaska was begun in cooperation with the Alaska Agricultural College and School of Mines July 1, 1930, when the first Federal appropriation of \$10,000 became available. The president of the college, Charles E. Bunnell, was appointed director of extension work in Alaska, and an assistant director for agriculture, G. W. Gasser, and an assistant director for home economics, Mrs. Lydia Fohn-Hansen, were employed July 1, 1930.

Leon S. Merrill, who had served as director of the extension service in Maine since 1914, relinquished that position December 31, 1930, to devote his entire time to his work as dean of the college of agriculture. He was succeeded as director of extension by Arthur L. Deering, who had been his assistant for a number of years.

R. S. Wilson, who had devoted more than 23 years to demonstration and extension work in Mississippi, resigned as director of extension work in that State August 31, 1930, and was succeeded by L. A. Olson, who had served as county agent and district agent for a number of years.

A. J. Meyer, director of extension work in Missouri since 1914, who had a large part in the development of the work in that State, died September 10, 1930. R. R. Thomasson was made acting assistant director in charge, October 21, 1930.

C. E. Ladd, director of extension work in New York, was on leave during the greater part of the year, and R. H. Wheeler served as acting director.

Thomas Bradlee, who had served as director of extension work in Vermont since 1914, when the work was started in cooperation with the College of Agriculture of the University of Vermont, died February 21, 1931. Joseph E. Carrigan, who had been assistant county agent leader for a number of years, was made acting director July 1, 1931.

Frank E. Balmer, who had been employed as county-agent leader in Minnesota for the last 17 years, was appointed director of extension work in the State of Washington November 1, 1930.

H. L. Russell, director of extension work in Wisconsin, resigned in April, 1931, and was succeeded by C. L. Christensen, who had served as secretary of the Federal Farm Board from the time it was organized. K. L. Hatch, assistant director in Wisconsin, was made associate director February 1, 1931.

SPECIAL DEVELOPMENTS

Through the increasing use of tractors and the larger farm machinery that goes with them, the use of more fertilizers and the planting of better seed, the larger use of legumes, and better organization of farms, farmers now are easily producing more food and fiber crops than the Nation will consume at a fair price to the farmer. Markets for American produce abroad are depressed. The problem before the farmer, therefore, is not so much one of production as of preventing overproduction, which always reacts unfavorably to him. These are some of the factors stimulating the great interest of farmers and extension forces in economics extension work.

The difficulties that farmers have experienced have brought forcefully to them the fact that they need more information concerning their activities, particularly on the business side and on general marketing principles and practices. Good farming to-day requires more attention than formerly to the problems of competition, to supply and demand, to credit and its costs, to margins and costs of distribution, and to many other problems of similar nature. There is also a growing appreciation of the fact that the present agricultural situation represents many problems and must be attacked from many angles.

In short, the field of economics extension is definitely broadening, and in 1930 much progress was made toward meeting, in broader fields and in a larger way, the increased demand for aid. The aim in this work is to develop and project a carefully planned program in which cooperating agencies and individuals have their selected parts and which, as it develops, unfolds into a piece of valuable educational extension work. The enlarged service in this field in 1930 was brought about through better organization, additions to personnel, greater emphasis on county extension programs, and increased volume of subject matter.

An increased Federal appropriation of \$1,000,000 for extension work and the demand for more extension work in farm management, marketing, and the use of agricultural outlook, caused the Extension Service to increase from 120 to 204 the specialists in economic fields. The total amount of time given by all extension workers to economics extension work increased about 50 per cent.

Reports indicate that never before has there been such a demand from farmers for assistance and counsel on their marketing problems. Improvements and shifts in production methods, highway developments, changes in marketing practices and in size and character of competing agencies, and changed attitude of farmers toward existing systems of marketing are responsible for many of the demands for facts and counsel on future plans and procedure.

The extension economics specialists gave efficient aid to the Federal Farm Board in developing regional plans for marketing staple farm products. Not only did extension economists and county agents assist the Federal Farm Board members in various parts of the country in holding meetings and conferences and in making other contacts, but they carried through the year aggressive educational programs dealing with marketing principles, policies, and practices.

In general, the activities were designed to promote understanding of marketing methods, solve mechanical problems, develop cooperative effort, strengthen cooperative associations, reduce marketing costs, improve packing, quality, and distribution, and encourage better business practices.

FEED GROWING STIMULATED

Both dairy and general farm livestock suffered severely in the drought early in 1930, and extension workers made a vigorous effort to encourage the growing of home-grown feeds. The entire live-at-home program which has been conducted in a number of States for several years, was given a greater impetus, and it is believed that many practices adopted under emergency conditions in 1930 will be retained as regular farm practices.

HOME GARDENS AND SURROUNDINGS

The need for adequately meeting the food requirements of the farm family and the intensive work carried on by food and nutrition specialists in many States, no doubt, materially encouraged the growing of more home gardens. The efforts made over many years by extension agents, toward making the home the center of farm life has led without question to increased interest in the landscaping and beautification of home grounds.

RECREATION DEVELOPED

Recreational activities are a developing phase of extension that received increased attention during the year. The National Recreation Association is now furnishing three men who, in cooperation with the State agricultural extension forces, give practically their whole time to training leaders in promoting recreation among rural people, both adults and juniors. This activity seems to be meeting a real need and is increasingly popular. During the year, over 5,000 leaders were trained in this work, which is designed to be not only recreational but health giving and socializing.

PROFESSIONAL IMPROVEMENT

Interest of extension workers in improving their professional ability was evident in the greater number of courses given by universities and colleges for extension workers desiring to follow advanced study in economics and other fields. Such courses were given at Cornell University, the Ohio State University, the University of Wisconsin, and the State Agricultural College of Colorado. Sabbatical leave for such study was given to agents in some States.

DISTRIBUTION OF ACTIVITY

The relative amount of time that county extension agents and specialists devote to the various subject-matter lines of work gives a fairly good picture of the national extension program. The distribution of time remains quite constant. (Table 1.) In the county agent reports for 1930 soils work has been distributed among the various crops. Time spent on organizing the people of the counties for extension work and in building the extension programs has been separated from miscellaneous activities for the first time.

TABLE 1.—*Percentages of agents' and specialists' ¹ time devoted to different projects, ² 1925-1930*

Project	1925	1926	1927	1928	1929	1930 ²
Soils.....	5.2	5.3	4.8	5.1	5.1	-----
Farm crops.....	13.1	13.1	12.4	11.5	11.6	15.2
Horticulture.....	6.9	7.3	7.1	7.3	7.0	8.7
Forestry.....	.5	.7	.9	1.0	1.0	.9
Animal husbandry.....	7.1	7.5	8.2	7.8	7.6	6.5
Dairy husbandry.....	7.0	7.1	7.9	8.7	8.6	7.7
Poultry husbandry.....	8.7	9.0	8.8	8.1	7.9	7.6
Rural engineering.....	3.7	3.6	3.4	3.3	3.2	3.3
Rodents and insects.....	2.0	1.7	1.5	1.3	1.1	1.3
Agricultural economics.....	3.9	4.0	4.1	4.0	4.3	6.2
Foods.....	4.8	4.6	4.6	4.4	5.2	7.0
Child care and training.....	-----	-----	-----	-----	-----	.6
Nutrition.....	2.3	2.6	2.5	2.6	2.3	-----
Clothing.....	7.9	7.1	6.8	6.8	6.9	6.7
Home management.....	1.7	1.5	1.5	1.7	2.2	2.1
House furnishing.....	1.2	1.8	2.0	2.4	2.6	2.6
Home health and sanitation.....	1.2	1.2	1.2	1.2	1.2	1.3
Community activities.....	6.2	5.9	6.0	5.8	5.9	4.0
Miscellaneous.....	16.6	16.0	16.3	17.0	16.3	7.5
Building extension program.....	-----	-----	-----	-----	-----	3.7
Organization.....	-----	-----	-----	-----	-----	7.1

¹ Only field work of specialists as reported by county extension agents is included.

² In 1930 time spent on soils has been distributed among the various crops, nutrition has been combined with foods, child care and training has been added as a new project, and time spent on maintaining the county extension association and in building extension programs has been separated from miscellaneous.

The annual report form used in 1930 also furnished for the first time some information on the ages of club members and the number of years they have been in club work. According to Table 2, 74.1 per cent of the boys and girls had been enrolled in club work for 1 or 2 years, 13.5 per cent had been enrolled 3 years, and the other 12.4 per cent had been in club work for 4 years or more. From Table 3 it will be noted that 40.8 per cent of the boys and girls in club work were 12 years old and under, 40.7 per cent were aged 13 to 15 years inclusive, and the remainder, or 18.5 per cent, were from 16 to 20 years of age.

TABLE 2.—*Membership in 4-H clubs according to length of time in club work*

Members	Percentage of club members enrolled for—					
	One year	Two years	Three years	Four years	Five years	Six years and over
Boys.....	47	25.9	14.2	7.5	3.3	2.1
Girls.....	49.8	25	13.1	7.2	3.1	1.8
Total membership.....	48.7	25.4	13.5	7.3	3.2	1.9

TABLE 3.—*Membership in 4-H clubs distributed according to age*

Members	Percentage of club members enrolled who were aged—										
	10 years	11 years	12 years	13 years	14 years	15 years	16 years	17 years	18 years	19 years	20 years
Boys.....	11.3	12	14.8	14.8	14.6	11.7	9	5.8	3.4	1.7	0.9
Girls.....	12.9	13.1	16.6	15.4	14.1	10.8	7.9	4.8	2.6	1.2	.6
Total membership.....	12.3	12.6	15.9	15.2	14.3	11.2	8.3	5.2	2.9	1.4	.7

COUNTY AGRICULTURAL AGENT WORK

LEADING ACTIVITIES

ECONOMICS

The year 1930 was one of extraordinary activity in the field of applied economics. This was true because of the general depression, falling prices, the great drought, the effort of the Federal Farm Board to reduce the production of certain commodities and to develop cooperative marketing on a nation-wide scale, and the growing recognition by extension agents and farm leaders of the need for studying and relieving the economic problems which beset the farmer. (Fig. 2.)

In many States the county extension program in agriculture expressed a serious effort to improve the agricultural situation by one or more of the following activities: (1) Determining production costs, (2) determining and teaching profitable farm business organization and management, (3) adjusting production to demand, (4) selecting enterprises and determining volume in line with outlook information, (5) reducing the costs of distribution, and (6) studying the need for and promoting education in successful cooperative marketing.

In Colorado, upon the suggestion of the Federal Farm Board that the burdensome surplus of wheat be reduced, a campaign to that end was conducted in the 14 counties that produce 85 per cent of the State's wheat crop. The international, national, and local wheat situations were explained to farmers by means of charts and graphs setting forth production trends, carry-overs, price trends, and tariff and freight barriers, and substitute crops were suggested. The net result of this campaign was that Colorado farmers reduced their wheat plantings 12 per cent as compared with 1929.

In Louisiana the agents used outlook information on cotton to help farmers adjust their plantings to meet the probable unfavorable situation. Farmers in nearly every community were given the outlook information and warned that the situation forbade expansion or demanded actual curtailment of cotton plantings.

The agents in Missouri were successful in bringing about a much stronger cooperative system in marketing a \$3,000,000 berry crop. A fruit producers' exchange was formed from 12 leading small organizations, and half the berry crop of the State was marketed through this agency.

The county agent of Weld County, Colo., reported that in cooperation with the State bureau of markets, a campaign lasting from December to May was used to organize a cooperative wheat pool. In all, 43 meetings were held, and 490 members enrolled. These members controlled 101,978 acres, representing 76 per cent of the last five years' average acreage. Weld County has about 10 per cent of the State's wheat acreage and 30 per cent of the acreage assigned to the pool. The same agent assisted in another marketing project—the exchange of seed potatoes between dry-land and irrigated districts. He reported:

This project got a splendid start with around 15 cars of seed being brought to the irrigated district. If most of the seed that is brought in from the outside and used in the irrigated section were brought from our own dry-land area, it would mean that about 75 cars would be used, which is about the present production of the dry-land area.

The types of economic enterprise work carried on by California county agents are shown in the report of the agent of Stanislaus County:

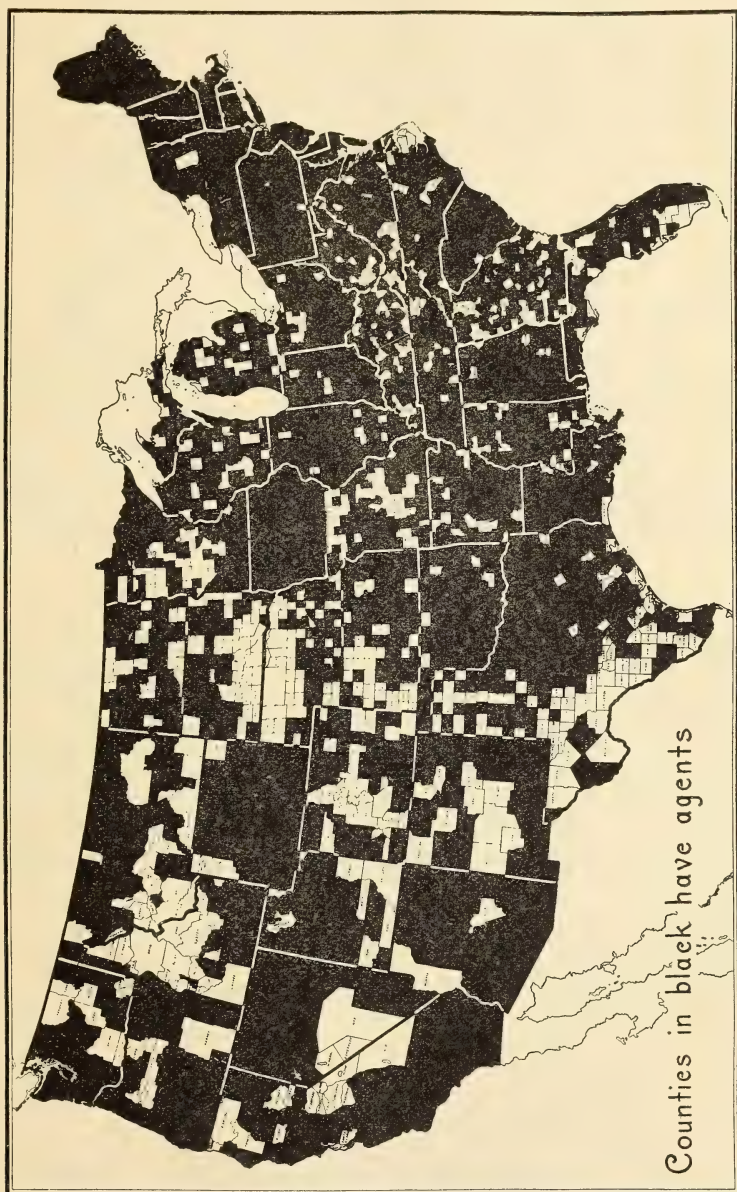


FIGURE 2.—Distribution of county agricultural agents

A series of 17 demonstration meetings on deciduous long pruning was held in 1930, with an attendance of 610 growers. The increased interest was due to the high price of peaches and apricots during the 1929 season. Economic data derived from previous studies on almonds, apricots, and peaches were presented in the form of charts at the field meetings. A comparison was

made between a cheap pruning job and one that was properly done. In 1929, when peaches were high, it was found that those growers who spent \$4 more for pruning had a return of \$250 per acre more than those who used the more drastic method of cutting back the trees and thereby reducing the crop.

Pruning costs average close to \$20 per acre for peaches, with an additional charge of \$2.50 to \$3.50 for brush disposal; for pruning apricots the cost is approximately \$16.50 per acre, and \$2.50 additional for brush disposal; almond pruning costs were about \$5.50 per acre, which included brush disposal.

The agricultural extension service spent considerable time during the early summer in assisting the Federal Farm Board with its plan of disposing of the 1930 grape crop in Stanislaus County. The extension service aided in the organization, suggesting leaders and men to help in the sign-up campaign. Twenty-four committee meetings with an attendance of 244 were held in connection with the grape-control plan. The greater part of six weeks was spent by the farm adviser in assisting in the grape campaign in this county. The final result was about an 88 per cent sign-up for the Federal plan in Stanislaus County.

Use of the agricultural outlook has become the leading farm-management project, and in many States the county agricultural agents hold outlook meetings throughout the year. In Minnesota these meetings, particularly in the fall, are concerned with the service outlook and with feeding operations with cattle and sheep; in the spring they concentrate on crops, dairying, and poultry. The general tendency in many States is to consider outlook facts in planning any important project. Adjustments to economic situations and trends, price changes, time of marketing, and costs of production as well as productive factors, all are used as a basis for outlining the practices a farmer should follow in bettering an enterprise.

DAIRY HUSBANDRY

Extension work in dairying is marked nationally by the following standard kinds of projected activity: Promotion and management of herd-improvement associations and bull associations; improved-sire campaigns and other breeding work; feeding schools; disease control; and in general, activity intended to improve the production of cows by better management, feeding, and breeding practices. During 1930 the county extension agents emphasized three comparatively new types of work: Adjustment of production to demand; production of high-quality milk; and organization of groups for a simpler and more economical method of recording and listing the production of cows.

Adjusting production to demand requires close contact with market situations and outlooks, and involves the task of teaching dairy-men to manage their production so as to take advantage of the better prices paid in certain months. Dairy farmers long have needed a simple and inexpensive system of checking the production of their cows and the cost of production. The so-called mail-order testing system used by the county agents in Wisconsin has proved its worth. In Wisconsin there are now 13 associations organized to use this system. Members of these associations own 2,567 herds totaling 38,185 cows. The county agent for Marathon County reports that the mail-order testing association in that county has enrolled owners of more than 400 herds. After three years of its work, farmers who have been members of both the standard herd-improvement associations and associations of the newer type, report that the new or-

ganizations give satisfaction, and give it at less cost than did the standard herd-improvement associations.

Regional laboratories for this system of testing and record work are set up in four counties in New York. The dairy-farmer member of the so-called dairy-record class weighs the milk of his cows, takes night and morning samples of each cow's milk, and sends these samples in especially designed containers to the laboratory, with his record of the weights of milk obtained and the weight of grain and forage fed to each cow. The milk is tested, the computations and records are made in the central laboratory, and the records, summaries, and instructions for each cow and for the herd are sent back to the farmer. In 1930, 354 herds and 4,919 cows were included in the work, at a cost of 12 cents per cow per month.

The short-cut or mail-order system of testing supplements rather than supplants the work of the regular herd-improvement association. Enrollment of cooperators who are not reached by the regular type of association results in a larger number of men systematically observing the feeding and production of their cows and then taking definite steps to improve their breeding and feeding. Encouragement is also given to organizing herd-improvement associations of the regular type. Fifteen new associations of this type were organized in New York.

Michigan county agents, with the aid of dairy specialists, are carrying out a highly developed dairy-extension program. Michigan now has 88 dairy-herd improvement associations embracing 1,721 herds and 2,286 cows. Dairy farmers in that State built 1,000 safety breeding pens last year. County agents and dairy leaders now are preparing to attack the problems of removing the 20,000 scrub and grade dairy bulls in Michigan and of testing more cows for production; only 5 per cent of all cows are now being so tested.

The county agents in the Southern States are working under unfavorable conditions to improve dairying and to put the industry on a firmer basis. The lack of home-grown feeds, particularly forages, and of productive animals, and the need for more satisfactory markets are real drawbacks. Yet the agents report most encouraging progress. In Clarke County, Ga., there is a purebred bull of known breeding in every community; 85 per cent of the cows are being bred to these bulls, and 70 per cent of the feed is grown at home. In Richmond County, Ga., 500 cows have been sold to farmers on an installment plan sponsored by two local banks. In northeastern Georgia, 216 result demonstrations in dairying were completed by 20 agents, and 149 registered dairy bulls were placed by 19 agents.

LEGUMES

County agricultural agents are making a nation-wide effort to persuade farmers to plant more legume hay and pasture crops. To several thousand county agents and the leaders working closely with them, alfalfa, clover, sweetclover, soybeans, hairy vetch, Austrian peas, and Lespedeza are symbols of a new wealth and a new order in farming. Illinois seeded 750,000 acres of sweetclover last year, despite the fact that only a few years ago sweetclover was still considered a weed. The whole State of New York has been drawn into

active cooperation in a clover and alfalfa campaign which was begun in a few counties in 1925. The cumulative effect of this long-time campaign is that many thousand acres of alfalfa or clover are newly planted in the State each year. Missouri reported an increase from 10,000 acres of soybeans in 1920 to 448,000 acres in 1930. The quantity of limestone used in Missouri grew from 9,020 tons in 1919 to 223,400 tons in 1930, an increase of about 2,370 per cent. The railroads cooperated in hauling 17 special trains of lime directly to fields on the right of way between stations. Two hundred and twenty-one lime pulverizers crushed native stone for local use in districts removed from railways.

County agents in Alabama reported that as a result of a state-wide campaign for winter legumes, 1,256,289 pounds of Austrian peas and hairy vetch seed was purchased cooperatively in 1930. This is a slight increase over the quantity purchased in 1929, but the total is remarkable when the drought and depressed financial situation are considered. The use of summer legumes kept pace with the advance in winter legume use; 20 carloads of soybean seed were brought into the State in addition to the quantities sold by local seedsmen and merchants. Wisconsin county agent reports show an increase in 10 years from 257,000 acres of clover and alfalfa to 1,308,000 acres, or 408 per cent.

County agents in the Corn Belt States have long emphasized the improvement of the corn crop. During the last five years particular emphasis has been placed on testing seed corn for diseases and for germination. In Whitley County, Ind., in 1930, 53,000 ears of seed corn were tested at the central station alone, and 17,000 ears were discarded as unfit for seed. Project leaders reported that 66,500 ears were tested at home by farmers.

Improvement of cotton is a major extension enterprise for all agents in the Cotton Belt. (Fig. 3.) The many demonstrations conducted by farmers under the direction of the agents have emphasized the production of cotton of higher quality at lowered costs. These demonstrations usually show a yield double that of the State average.

POTATOES

Extension work in improving potato production is an important activity in many Northern States. The effort to obtain high yields through the use of certified seed, the use of certain strains of seed, the use of rotation crops, seed-bed preparation, fertilizers, and disease and insect control still engage the attention of county agents. In the Eastern States 300 or 400 bushel potato clubs are organized to stimulate the farmers' interest in adopting the practices demonstrated. During this year, greater attention than before was given to producing high-quality potatoes. Use of padded diggers, better handling practices, disuse of lands infested with wireworms or lands too heavy and soggy to produce high-quality potatoes, are practices which have followed the teaching efforts of county agents in potato-growing counties. Wherever market conditions are favorable, planting larger units has been encouraged, in order to cut the cost of production by more economical use of labor and machinery.

HORTICULTURE

Clubs or contests were conducted by extension agents to stimulate interest in higher yields and economical production. For instance, 90 per cent apple clubs are intended to influence the fruit grower to apply the recommended sprays more carefully, in order to obtain fruit 90 per cent free of insect or disease injuries. The spray-information service extended through the county agents has resulted in the production of more marketable, higher-quality apples in the East. The spray service is highly organized in some States. During the fruit-development season New York counties cooperate in



FIGURE 3.—County agent making adjustments on a riding cultivator to obtain greater efficiency of operation

the employment of special assistant county agents who have charge of the spray-improvement programs. The men in charge of the spray services maintain close touch with local and district weather-forecasting offices, and in most counties a telephone relay system is set up to give information to the growers at the most crucial times.

An example of the aid to growers which has been developed by the extension service, is cited from Plymouth County, Mass., where the annual cranberry crop is worth \$3,500,000. Diseases and insects were seriously affecting the cranberries. Plymouth County and Barnstable County, adjoining, cooperated in engaging a special assistant county agent who works with cranberry growers three months a year. He cooperates with the director of the cranberry research station at Wareham, and gives the growers personal service on problems of management, and disease and insect control. Special

disease, insect, and frost warnings are relayed from the research station to the operators of the cranberry bogs.

County agents are alert to help farmers meet every new need. The agent in Chelan County, Wash., has been urging orchardists to put stands of bees in their orchards to insure better pollenization and fruit setting. The demonstrations which he carried out resulted in the placing of 3,000 stands of bees in the Wenatchee district in Chelan County, with a consequent large increase in the fruit crops.

PEST CONTROL

The control of grasshoppers and other field-crop insects, and of rodent pests of field and range creates perennial problems in the far Western States. The county agents, in cooperation with State and Federal specialists, are making the annual warfare well organized and systematic, and each year win greater cooperation from farmers and stockmen. Last year, in Maricopa County, Ariz., the county agent and the farmers joined to fight grasshoppers. The county commissioners appropriated \$5,000 to purchase material for poisoned bait. The county agent conducted a systematic campaign. Bait mixing and distributing centers were set up in different sections of the county and supplied 760 farmers. Sixty-seven tons of bran, 2,690 gallons of molasses, 250 pounds of banana oil, and 6,700 pounds of crude white arsenic were used in preparing the bait. The farmers themselves applied the poisoned bait, distributing it over 56,500 acres.

Agents carrying on rodent-control work in Arizona enrolled 3,025 cooperators in 14 counties; 65,042 quarts of poisoned grain were used on 429,189 acres.

POULTRY

The grow-healthy-chicks campaigns are almost a nation-wide feature of the poultry extension work carried on by county agricultural agents. These campaigns strike at the fundamental problem of reducing the mortality among baby chicks and rearing vigorous pullets, free from disease and parasites, and capable of producing the largest number of eggs over a long laying season. The essential practices recommended, such as obtaining chicks free from pullorum disease, hatching chicks early, and rearing them in clean brooder houses on clean grounds, with clean feeding and management, have been adopted by thousands of farmers and poultrymen, and have resulted in a great reduction of mortality and in the production of pullets which lay more eggs.

County agents in Connecticut report a mortality of only 7 per cent of the chicks when the cooperators followed all of the eight recommended practices. In other States the average mortality of all chicks whose owners were enrolled in the campaign runs about 12 per cent as against previous mortality losses of from 30 to 40 per cent or more.

In New York 18 county agents are carrying on healthy-chick campaigns with 100 or more cooperators in each county. Kansas agents report 1,666 cooperators in the clean-chick program with an average of 88 per cent of all chicks being reared. Alabama agents report 106 demonstrations completed in 13 counties, in which 43,800 chicks

were involved and chick losses were kept down to 12.5 per cent. New Hampshire agents report 796 grow-healthy-chick cooperators raising more than 1,000,000 chicks in accordance with the recommended practices. County agents in New Jersey report that 1,325 cooperators were pledged in 1930 and began the season with 1,937,604 chicks.

ANIMAL HUSBANDRY

Hog parasites and diseases long have reduced the profits of farmers in the Central States. To meet this problem, specialists, agents, and farmers have united on four or five practices directed against these diseases and parasites. The extension workers have interested farmers in cleaning the sows and allowing them to farrow in pens or houses that have been cleaned and disinfected, and in moving the young pigs to clean ground known to be free of disease and parasites. They urged methods of feeding which would insure the most thrifty and rapid growth. The county agent of Holt County, Mo., reports that 123 farmers out of 135 enrolled, show records of 7.2 pigs raised per litter as compared with the county average of 5.7 pigs. These farmers were able to market 65 per cent of their hogs weighing 200 pounds at 6 months of age, as compared with the county average of 16 per cent so marketed. The Missouri agents report that farmers in that State docked and castrated 278,311 lambs in 1930, nearly twice as many as in 1929, thus helping the State to win the national lamb-improvement contest for the second time. This report illustrates what county agents are accomplishing in important livestock-producing counties.

FORESTRY

The county agents have given much time to teaching and encouraging farmers to apply good forestry practices on the farm wood lot and on idle or submarginal land. The wood-lot improvement work consists largely of teaching farmers to cull their lots systematically, removing ripe, crooked, diseased trees or trees of undesirable varieties, and thus maintaining the lot as a permanent and growing asset on the farm. The agents have had difficulty with this work because with high labor costs, or no local market for lumber, the farmer has been skeptical about the value of the recommended usage and practices. Similarly, in encouraging farm reforestation, the agent has had to meet the farmer's indifference to planting a crop which can only be harvested 30 years or more hence.

The problem of marginal and submarginal lands is acute in many areas. The county agent in Oneida County, Wis., found that 109,140 acres of land had become tax delinquent. Can the county take it over and reforest it? Several counties in New York have appointed assistant county agents whose sole work is in forestry.

AGRICULTURAL ENGINEERING

The prevention of soil washing and land erosion continues to be the most important agricultural engineering activity in all the Southern States. A sense of the need for erosion control is fast developing in many Northern States. The work of making farm and home life more comfortable by home conveniences and labor-saving devices

engaged both county and agricultural agents and home demonstration agents as never before. Obtaining electricity, and installing simple home water plants and septic tanks as prerequisites to modern home water and sanitary systems, are on the programs of hundreds of agents.

The vastness of the problem of controlling land erosion has impressed many county extension agents. Mississippi county agents report that in 58 counties 3,777 farmers completed terraces on 104,281 acres.

PROBLEMS IN EXTENSION TEACHING

County agricultural agents and specialists are improving their methods of teaching farmers. This improvement is evident in more systematic work; more detailed planning; use of a greater variety of teaching means and agencies; and in continuing the teaching on one problem over a longer period. The collection of more data on local situations and needs as a preliminary to diagnosing local problems, and the development of solutions which fit local needs and which are practical and economical, are also noteworthy.

One of the greatest advances is the effort to state practices recommended as solutions to local problems, in such form that each is an injunction and yet a practical, clear-cut direction which every farmer can understand. Generalities such as Plant shallow, Use approved varieties, Spray frequently, Use adequate amounts, are gradually abandoned for more specific directions which are kept before the farmer through a variety of agencies. Thus, "the path to more dairy dollars," which New York county agents are teaching, includes the following sharp, terse recommendations:

- (1) Feed Holstein and Ayrshire cows 1 pound of grain to every 3½ pounds of milk.
- (2) Feed Guernsey and Jersey cows 1 pound of grain to every 3 pounds of milk.
- (3) Feed cows on pasture 1 pound of grain to every 5 or 6 pounds of milk.
- (4) Plan to keep cows which, when 5 years old, produce at least 7,500 pounds of milk or 250 pounds of butterfat annually.
- (5) Raise only the calves from those cows which give at least 8,500 pounds of milk, or 300 pounds of butterfat, annually.
- (6) Keep a bull, the mother of which produces more milk and butterfat than the best cow in your herd.

The long-time campaign, based on teaching a large number of farmers to be successful with a limited set of new practices, is a feature of the work of many county agents. Such campaigns are based on the idea that learning is not an effort and a strain but a natural result of the individual's recognition of underlying problems and of their solution as an answer to his wants.

The county agents are rapidly learning to search for local data on situations and needs before advocating certain recommended practices. Agents who actually use farmers to survey and study local situations find that they have a real basis for diagnosing a local problem and can determine a solution which is practical and fitting. Then, too, through self-discovery and self-conviction, the farmers who take part in these preliminary studies, become stronger advocates of the solution recommended.

Several States, notably Illinois and Michigan, are using trained volunteer local leaders to teach other farmers certain recommended

practices. The gain in adoption of practices is noteworthy. Experience has shown, however, that care must be taken to teach only practices based on a real diagnosis of local situations and needs. Otherwise, stereotyped practices and projects may be recommended for situations which they do not fit, or local problems of great importance may be overlooked in the attempt to impart generalized or even formal knowledge.

There has been great improvement in the design and use of circular letters. Printed, illustrated letters, with their clean appearance, clear-cut appeal, and well-written subject matter, have shown many agents that the circular letter can be made one of the most convenient and economical means of reaching farmers. Agents are experimenting with other teaching aids, such as circulars, news articles, and news columns, and are improving their use. (Fig. 4.)

The radio has found its place as an agency of great value in introducing recommended changes to large numbers of people, when used by extension workers to support and supplement a variety of teaching agencies.

The county extension agents are utilizing volunteer community committeemen with increasing effectiveness in sponsoring work, studying problems, finding solutions, planning the teaching, and encouraging their neighbors to join the ranks of those who are successful through following the extension teaching.

The tenure of office of county agricultural agents is growing longer in most States. Extension workers and others in many States are looking forward to the time when the salaries of the county agents will be paid entirely from Federal and State funds, and their expenses will be paid from county funds. Much still must be done to improve office facilities and conveniences for the county extension agent, and to provide him with clerical help.

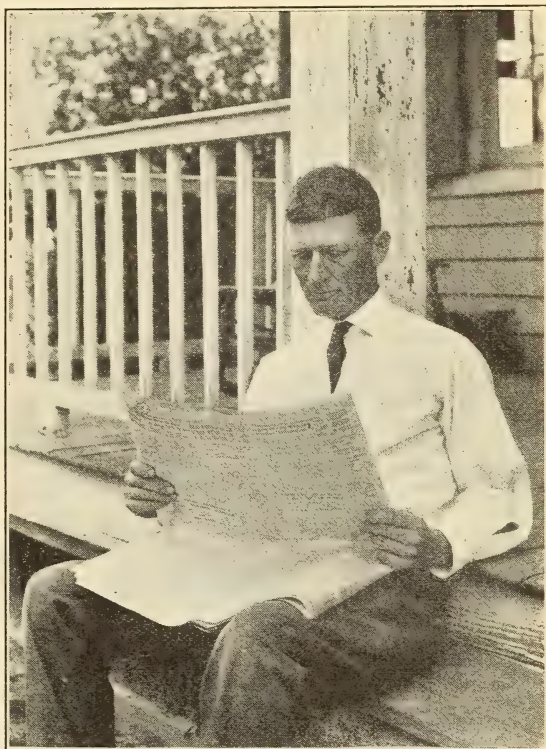


FIGURE 4.—Extension workers find news articles a valuable agency for giving information to farmers

Without a fully equipped office and competent full-time office help, few agents can give the service that farm people need.

One State leader in the East reports:

This office is becoming more and more a department which deals with county agent extension methods. As the years go by we are acquiring through experience and exchange of ideas with other States, a certain technic of adult teaching which is becoming more and more effective. When a subject is taught, we help to plan the work so that as much attention is given at least to methods in teaching as is given to the development of the subject matter. This system is resulting in a far greater spread of practice in the counties.

HOME DEMONSTRATION WORK

PROGRESS

A greater number of extension activities relating to the rural home and to rural life were conducted in 1930 than in any previous year. The keen interest and enthusiastic response from farm women throughout the country made heavy demands upon the Extension Service. That these demands were satisfied can be attributed to the following:

Increased number of county home demonstration agents. The total number of county and assistant county home demonstration agents employed on June 30, 1930, was 1,352, a 5 per cent increase over the previous fiscal year. (Fig. 5.) Of this number 127 were negro agents. There were also employed 202 home-economics specialists, an increase of 11 specialists over the number employed in 1929.

Increased responsibility assumed by county agricultural agents, in counties without home demonstration agents, in developing projects relating to the home.

More time and assistance given by State agricultural specialists in developing agricultural projects in which farm women are interested, such as poultry, gardening, home dairying, landscape gardening, and home engineering.

Greater stabilization in county and community organizations. Cooperative relationships in conducting home demonstration activities continued with increased satisfaction.

Noteworthy progress in the development of local leadership, providing a responsible source of assistance in furthering extension activities.

Attention given to State and county project plans, defining more definitely the organization, goals set, and methods of presenting projects. Systematic planning stimulated production of high-quality work and greater results. Programs and calendars of work made by State leaders, State home-economics specialists, and county home demonstration agents, have made possible more effective work and a larger amount of work.

Basing the home demonstration program in the community and county not only on immediate needs but on long-time development. Programs were discussed and planned in conference by farm people and extension workers, following studies and surveys in which farm people participated.

Enrichment of the home demonstration program by introducing such projects as design and color in clothing, house furnishing, and home arts and crafts; attractiveness of the farm-home surroundings and beauty in the countryside, appreciation of good music and pictures, selection of reading for the whole family, pageantry and plays for the community, and organized recreation for home and community.

Using more effective plans and methods each year in conducting home-demonstration activities. Such plans and methods are designed to reach a larger number and to give helpful publicity to the service.

Meeting emergencies quickly and effectively by adjusting the programs to take care of urgent needs in drought and flood areas.

In 1930 there were 34,959 organized groups of women who devoted their full program to home demonstration work, with 646,340

women enrolled, a 10 per cent increase in enrollment over that of 1929. The enrollment was reported as follows: 444,506 women, or 69 per cent of the total enrollment, by county home demonstration

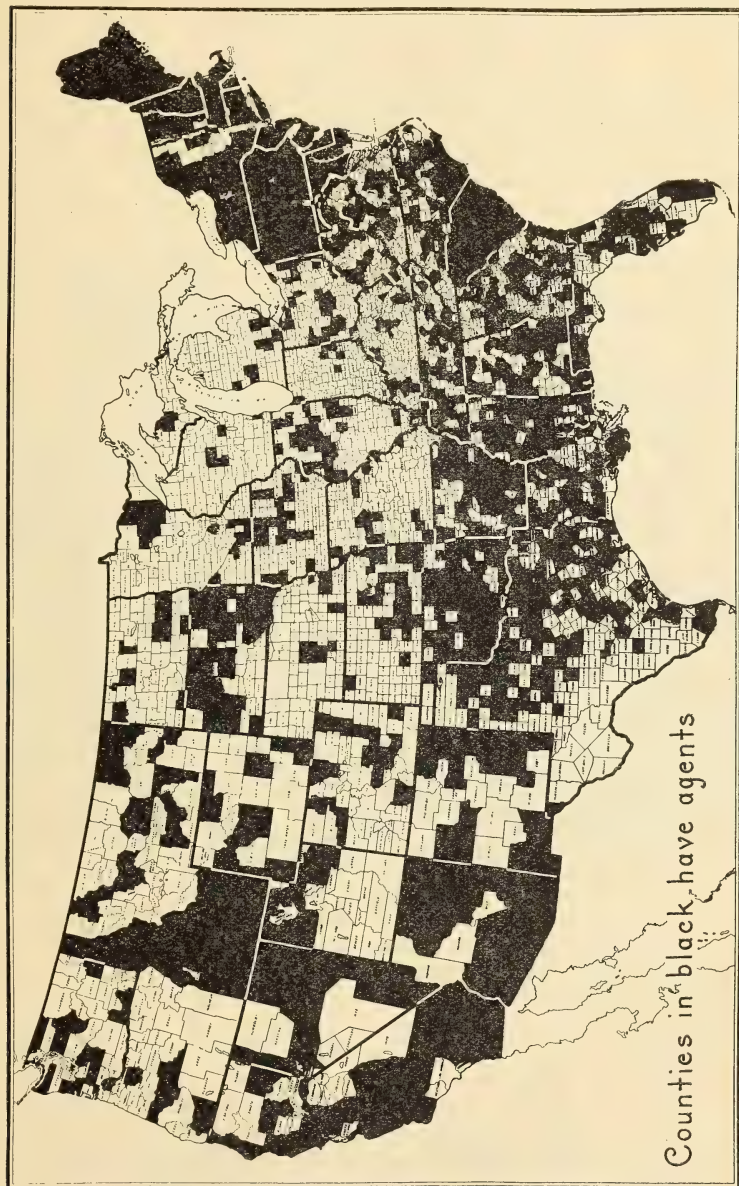


FIGURE 5.—Distribution of home demonstration agents

agents; 200,980, or 31 per cent, by county agricultural agents; and 854 by county 4-H club agents. Demonstration meetings held by home demonstration agents alone had a total attendance of 4,614,506 persons.

Home demonstration activities were reported by 1,198 county agricultural agents—51 per cent of all such agents. State home demonstration leaders and home-economics specialists assisted the agents in conducting the work, and local community leadership was effectively assumed by farm women.

HOME DEMONSTRATION WORK IN ALASKA

One of the newest developments of interest during the year was the organization of home demonstration work in Alaska. In 1930, seven groups of women were organized for home demonstration work and fourteen 4-H clubs for girls and boys were formed. The extension activities for women are largely in gardening, food selection and preparation, and food preservation. Some work in home improvement, in house furnishing, and in clothing construction has also been started. Clubs for young mothers are being organized to study child care. Home arts and crafts are being encouraged as a profitable use of leisure time.

HOME DEMONSTRATION WORK IN HAWAII

Creditable progress has been made in the home demonstration activities in Hawaii since the organization of the service in 1928. The groups of various races, including Hawaiian, Japanese, Portuguese, Filipino, Chinese, Chinese-Hawaiian, and whites, are involved in such work. The home demonstration agents in the four counties reported 942 women enrolled in 41 organized groups and 838 girls enrolled in fifty-four 4-H clubs in 1930. The home demonstration agents reported 909 meetings with a total attendance of 15,480. In addition 41 home demonstration and 4-H club meetings featuring achievement-day programs, exhibits, demonstration dinners, and recreation were held. Two demonstration tours, two encampments for women, and four 4-H club encampments were conducted.

The women and girls, especially the Japanese, showed enthusiastic interest in food selection and preparation. There were 619 women and 393 girls enrolled in food projects. All recipes used in the demonstrations were printed in Japanese newspapers as well as in English newspapers. Emphasis is being placed on a greater use of vegetables, fruits, and milk, and on their proper preparation. Making native fruits such as the papaya, mango, guava, and pineapple into attractive jellies and jams for home use and for market has been a successful enterprise with women and club girls in the Kona district of Hawaii. In 1930 there were 1,500 jars sold with promise of larger sales the next year. There were seven garden clubs with 150 women enrolled. These women introduced a greater variety of leafy vegetables into the home gardens. The home demonstration agents cooperated with the county nurses of the public health service in the preschool clinics by giving food-preparation demonstrations at the clinic. A large number of mothers with young children were benefited by these demonstrations, and the plantation managers often provided trucks to carry the mothers and children to the clinics.

PROGRAMS OF WORK

Throughout the country the farm women, with the guidance of extension agents, determined programs of work for their own communities after considering (1) a list of activities based on requests,

(2) the continuation of projects already under way, and (3) the needs of the community as analyzed by the group. The resources of county extension agents, the number of communities to be served, the tenure of extension work in the county, the kind and amount of State specialists' assistance available, are all factors which have influenced program determination.

County home demonstration advisory councils or committees functioned in compiling and setting up the county home demonstration program. (Fig. 6.) From the community programs the county program and goals are compiled, together with the indorsement and suggested emphases of the council. The county program pictures the home demonstration work of the year and is usually published.

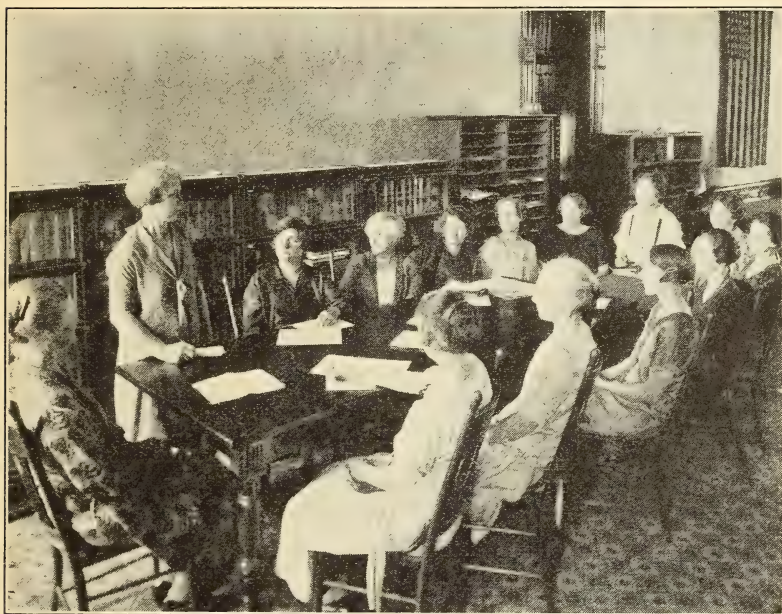


FIGURE 6.—A county committee of local women planning the home demonstration program for the year

Informal county surveys for ascertaining the needs and wants of farm women were used to some extent in New York, Delaware, Maryland, North Dakota, South Dakota, and Montana. Their findings served as bases for discussion at program-making meetings of the county councils or county committees.

COUNTY ECONOMIC CONFERENCES

The group-discussion type of conference gives opportunity, under an organized plan, for free expression on the part of farm people. The 2-day county farm-home economic conference has proved popular. In such conferences farm women or men and women meet and discuss farm-home conditions and needs. The data obtained in advance by the surveys have been largely economic information on food; clothing; physical equipment, general conditions, and man-

agerial aspects of the home; and the cost of living. These data have served as good bases for shaping questions to be discussed at the conferences. Committees of farm women, assisted by both the home demonstration and agricultural agents of the county, by the State home demonstration leader, home-economics specialists, and several of the agricultural specialists, plan and conduct such a conference, the several steps in its development covering three or four months.

These conferences make recommendations and suggestions for solving economic needs, and set standards for farm living which accord with the ideals of the local people and the possibilities of the locality. Setting up goals or standards stimulates constructive thinking and desire for accomplishment.

Twenty-three county economic conferences, in which farm-home conditions and interests were considered, were conducted in 1930 in 10 States—Arizona, Colorado, Utah, Nevada, Washington, Wyoming, South Dakota, North Dakota, West Virginia, and Vermont. The conferences resulted in immediate or renewed emphasis being placed upon projects recognized by the discussion groups as meeting the needs of their counties. These recommendations have been considered by county councils and extension workers in setting up long-time goals. The cost-of-living budgets giving the amounts thought necessary to maintain the standards of living set up afforded interesting discussion programs for a series of community meetings.

PROGRAMS IN DROUGHT AREAS

Home demonstration work proved its efficiency in meeting emergencies in 1930 as well as it did during the World War. All forces in the severely drought-stricken regions were directed toward guiding and instructing the people in preserving any available foods for winter use and in maintaining a safe diet at minimum cost. Special attention was given to the prevention of pellagra. Home demonstration agents in North Carolina cooperated with the State department of health. In 27 counties they sent 486 pellagra patients to physicians and gave information on corrective feeding to 1,050 patients in 45 counties.

To avoid the necessity of feeding animals through the winter or selling them at very low prices, as well as to provide a winter supply of meat for themselves, farm families in the drought region canned large quantities of beef and chicken. Meat-canning centers were set up under the direction of extension agents. In these centers cold-storage facilities and screened workrooms with steam-pressure canners and mechanical can sealers were made available for the use of farm people. Rules covering the chilling of carcasses and forbidding the slaughtering of overheated or underfed animals were followed. In Arkansas home demonstration agents gave 1,437 meat-canning demonstrations in 1930, and local leaders gave 519. Farm families in Arkansas canned 272,251 pounds of beef. If the beef had been sold on foot it would have brought at that time approximately \$14,123.13, whereas the canned products were valued at \$58,057.38.

In areas where rains made fall gardens possible extension agents cooperated with relief organizations in intensified garden campaigns,

distributing garden seed, giving instructions for planting, and encouraging the canning of surplus fall field and garden products for winter use. Extension workers also assisted impoverished families in solving clothing problems.

LOCAL LEADERSHIP

Each year brings a noteworthy increase in the number of women who serve as voluntary leaders. In 1930 there were 103,151 leaders assisting in conducting home demonstration work, an increase of 37,223, or 57 per cent, over the number in 1929. The women who, without financial remuneration, gave time and effort to home demonstration activities and to 4-H club work with girls numbered 141,958.



FIGURE 7.—A local leader demonstrating baking at a meeting of a home demonstration club

These leaders felt repaid by the training and experience they gained, by the opportunity of association with extension workers, and by the satisfaction that came to them in helping their friends and neighbors. (Fig. 7.)

EXTENSION METHODS

After any phase of home demonstration work has been introduced into the community program, three distinct steps in the extension process are found necessary: (1) The presentation or suggestion that attracts interest sufficient to result in individual action; (2) the application of the information or improved practice by those who have become interested and who demonstrate in their own homes; and (3) an organized effort to bring the successful demonstration to the attention of a larger number in order to encourage a wider adoption of the practice and to obtain public interest and approval.

Methods of presentation vary in effectiveness under different conditions, and it may take several avenues of appeal to get the desired response—the adoption of the practice in the home. The demonstration lecture is used generally. The laboratory method of presentation has proved to be more effective. It is the participation of the women in the method demonstration, under the instruction of the extension worker. Visual instruction is used extensively. Such illustrative material as actual equipment and furnishings, models, photographs, posters, charts, and diagrams has been used with the lecture or with the method demonstration. Bulletins, pamphlets, newspaper articles, exhibits, lantern slides, motion-picture plays, pageants, and radio are used to reenforce extension presentations, and all play a part in inducing action. The number of radio talks made was 709, reported by 220 county home demonstration agents. Educational agencies and commercial interests have contributed generally to extension work in furnishing illustrative materials.

Demonstrations conducted by the farm women in their own homes are the most effective means of getting extension information and improved methods put into actual practice. There is a marked tendency toward use of the simple 1-unit demonstration which leads to larger and more difficult demonstrations. Closer supervision of these home demonstrations by extension agents and local leaders was encouraged in 1930.

It has been found that adults respond enthusiastically and effectively to contests. Kitchen and living-room improvement, vegetable and flower gardening, farmstead beautification, making house dresses, and writing news articles relating to extension work, are some extension activities in which contests for women were conducted in 1930. The closing events and presentation of awards were sometimes held in connection with county or district short courses or encampments. Score cards giving points which make up good standards have been used as a basis for judging in contests, and are increasingly used as a means of teaching good standards in food, clothing, and health projects.

Press articles, organized campaigns, achievement days, automobile tours, popular community programs, exhibits, plays, and radio programs have contributed toward bringing a successful demonstration to the attention of a large number of people. Automobile tours were popular and effective in directing attention to results obtained in kitchen improvement, house furnishing, gardens, and farmstead-beautification projects. Six hundred and twenty county home demonstration agents report conducting 2,090 tours in 1930 with an attendance of 118,041. Public demonstrations by teams of club girls were used to extend the influence of the clothing, food and nutrition, and house-furnishing projects. Home demonstration agents trained 15,889 judging and demonstration teams of 4-H club girls.

LEADING ACTIVITIES

FOODS AND NUTRITION

The project of foods and nutrition had an important place in the home demonstration program in 1930. During the year, 1,670 extension agents reported holding 84,176 method-demonstration meet-

ings featuring the several phases of the food and nutrition program, and 98,776 result demonstrations were completed or carried into the next year by farm women.

Standards of good nutrition, wise selection of food, and well-planned meals properly prepared and served, were generally emphasized in the foods and nutrition program in 1930.

The relation of food to health was given major emphasis in the several project phases, by extension workers who pointed out the alliance of good growth and development with correct food and health habits, gave information on the causes of overweight and underweight, and pointed out that many adult ailments are the results of faulty food and health habits.

Drought in certain regions and low prices for farm products in all regions led in 1930 to the important consideration of how to get the most for the food dollar. Meeting the needs of family health with lessened expenditure of money called for more careful study of food values, increased production of home fruits and vegetables, an increased amount of canning and other types of food preservation. It was reported that 73,396 families planned food budgets including the canning budget. Canning on the budget basis has become a general practice in a large number of homes.

The extension agents have been active in food and nutrition teaching for young mothers with preschool children, and in many instances have succeeded in bringing about school-home correlations to meet the nutrition needs of school children. A total of 69,403 homes improved the home-packed school lunch in 1930, and 5,913 installed the hot school lunch on the recommendation of extension agents.

HOME GARDENING

The chief objective in the home-garden demonstrations has been to increase the supply and variety of green and leafy vegetables, to produce enough vegetables and fruits to insure a canned supply for use through the winter months, and in some cases to increase the family income by the sale of the surplus not needed for home use. It was reported by 1,119 county extension agents that 64,703 adults completed home-garden demonstrations in 1930.

Twenty women in Gadsden County, Fla., kept accurate records of the kinds and amounts of vegetables used by their families and were surprised to find that the gardens had saved from \$97 to \$247 on grocery bills. State-wide garden contests were reported by Oklahoma, West Virginia, Georgia, South Carolina, Mississippi, Arkansas, and Florida. In Arkansas 2,716 women entered the year-round garden contest and 2,214 completed it in spite of drought during the summer.

POULTRY

The home-poultry project held an important place in the live-at-home programs, especially in the Southern States. In 1930 county home demonstration agents guided home-poultry demonstrations carried on by 21,616 women, 2,504 boys, and 31,345 girls. The extension workers have assisted farm families to develop their poultry flocks as means of supplying family needs and increasing farm income. The instruction has centered on improving the farm flock by

following a clean and healthy chick program, using artificial incubation when it is practicable, properly feeding and housing the flock, culling the flock, producing infertile eggs, and by preparing poultry and grading eggs for market. Poultry shows and egg-laying contests gave zest and interest to the work with poultry.

DAIRYING

"From a pint to a quart of milk daily for each member of the family for growth and health," a slogan which embodies a principle used in one of the score cards for nutrition projects, has been cited as indicating a vital reason for keeping at least one cow on every farm, under ordinary conditions. For a number of years, educational dairy work urging greater use of milk has been carried on by the extension service in States where there are not enough cows to supply the needed amount of milk. The home demonstration agent of Charleston County, S. C., reported in 1930 that satisfactory results had been accomplished during the last 10 years; that in 1920 there were 132 cows placed on farms where there had been none, whereas in 1930 only 7 were so placed. She also reported that 10 years ago there were no cows on the great majority of farms in the county, while in 1930 there was a cow on practically every farm.

In a few Southern States, home dairying was carried as a home demonstration project in 1930. Such phases as feeding and caring for the cow, clean milk production and cooling, sterilization of dairy utensils, and butter and cheese making were demonstrated.

CLOTHING THE FARM FAMILY

The clothing project led all other home-economics projects in enrollment in 1930, with 713 extension agents reporting 88,952 adult result demonstrations completed and 1,936 agents reporting an enrollment of 301,354 girls and 1,196 boys in 4-H clothing clubs.

In some sections economic conditions had a direct bearing on clothing the family. Fewer articles of new clothing were bought, and there was a growing interest in making old clothing look up to date. A total of 194,953 women and girls followed recommendations on renovating and remodeling, while only 125,313 women and girls followed such recommendations in 1929. Safe and effective dry-cleaning methods were emphasized as an economy measure in the clothing program in a large number of States.

Several States organized special projects in the economics and buying of clothing. Studies in better buying are made to familiarize the women with textile values, cut of garments, cleaning and laundering qualities, and standard sizes, and to make them more intelligent buyers.

Standards in the dress of farm people are higher than they were 15 and 20 years ago. This improvement is not due to excessive expenditure for clothes but to education in what is healthful, appropriate, and attractive in dress. Increased self-confidence and assurance have come with the higher standards.

In order to enable them to take inventory and to plan wardrobes to the best advantage commensurate with the money available for clothing, women and girls enrolled in the clothing projects have been

encouraged to set up clothing budgets. In 1930 such budgets were made by 13,889 women and 27,175 girls. Some had kept clothing accounts the preceding year, and therefore set up their new budgets on the basis of valuable experience.

HOME MANAGEMENT

Home-management extension projects involved the two major managerial problems of the home maker: (1) The management of time and energy and (2) the management of income or the material resources.

Among the demonstrations which had for their ultimate goal the conservation of time and energy were those of labor-saving home equipment; kitchen improvement and rearrangement; installation of modern water-supply, sewage, lighting, heating, and refrigerating systems; improved laundry methods; housekeeping methods and schedules; and conservation of time and energy. The extension projects in management of income were keeping household accounts, budgeting the income, buying, and studies on the cost of living which were carried on largely in connection with research projects.

Approved labor-saving equipment was installed in 40,896 homes in 1930, it was reported by 848 extension agents. The following items of comparatively expensive and permanent equipment were reported as having been installed according to recommendations: 4,211 water systems, 4,931 lighting systems, 3,911 sewage-disposal systems, and 639 heating systems.

Saving time for useful leisure is a matter that is being given serious consideration in the home-management projects in several States. This saving is sometimes accomplished by making a time schedule for the day's or week's work, comparing it with the time actually required for various tasks, and so adjusting it as to save a few minutes here and there. Many persons have been surprised to learn that thoughtful planning of farm and home duties provided time for many delightful interests, such as reading, entertaining friends, and more companionship with the children. Improved equipment and the allocation of home duties to all members of the family have also helped to provide this leisure time. Progress in this phase of home management was reported in 1930 by 405 extension agents, who stated that 23,554 women were following recommended schedules for home activities.

Home account-keeping was noticeably stimulated in counties where the county farm-home economic conferences were held, because the women wanted to check on the budgets set up in the cost-of-living discussion groups.

During 1930, 437 extension agents reported 13,801 women keeping accounts, whereas in 1929, only 10,591 were reported as making budgets and keeping accounts.

IMPROVEMENT OF HOMES AND SURROUNDINGS

The plans and suggestions given by extension agents in home-improvement projects have provided the maximum of convenience and attractiveness at the minimum expense. The improvements recommended ranged from doing over old furniture to planning a

new house. Women and girls appreciated information and suggestions on making the home restful and attractive; 47,320 adult result demonstrations were completed in 1930, and 91,247 girls and 729 boys were enrolled in 4-H clubs featuring house-furnishing projects.

The principles of good decoration and furnishing were applied in appropriate and inexpensive ways to living rooms and other rooms. One home demonstration agent in Florida thus described the results: "The living rooms in hundreds of Florida homes are now attractive gathering places for the family, and places conducive to the development of a 'higher life' within the home." This room-improvement work has often been stimulated by the rearrangement or improvements first made in the kitchen or the improvements made by the 4-H club girl in her own room, which often awakened the whole family to the need of general home improvement. The refinishing of old furniture, harmonizing colors, and proper arrangement of furniture improved the interiors of many homes. Such simple changes as discarding gaudy pictures, dyeing inexpensive drapery material, adding homemade rag rugs, and properly placing vases, lamps, and flowers, were keynotes of beauty in many humble but attractive homes. Where more funds were available more elaborate improvements were made. At least 150,000 women and girls made improvements in their homes in 1930, following the suggestions of extension agents.

The specialists in rural engineering have cooperated in the home-improvement program by furnishing plans for houses that were practical and appropriate for different localities. The reports show that the Extension Service assisted farm families in planning 1,824 new houses, and 2,883 were remodeled according to plans furnished.

Improvement of the home grounds, or farmstead beautification, made steady progress as an extension activity; there were 41,768 adult result demonstrations in 1930, while 14,364 girls and boys enrolled in yard-improvement clubs. Improving the interior of the home has in many cases been an incentive to beautifying its outside as well. The demonstrations usually follow a long-time plan and sometimes are under way for three or four years. They involve cleaning up and painting the entire premises, making open lawns, foundation plantings, using native shrubbery, planting trees where needed and flower gardens in appropriate places, and improving walks and roadways.

The same principles of landscaping have been applied to the improvement of school grounds and other public grounds as a community activity sponsored by the local home demonstration clubs or 4-H boys' and girls' clubs.

CHILD CARE AND TRAINING

Child care and training as an extension project has not passed the experimental stage in most States, but the response of parents and the growing demand for extension assistance in the subject by community groups attest its success in meeting a need in farm family life. Nine States employed specialists in child care and training in 1930; New York, New Jersey, Massachusetts, Georgia, Oklahoma, Illinois, Iowa, Michigan, and Minnesota. Nineteen States conducted extension work

in some phases of child care and training. Other States conducted some of its phases in correlation with foods and nutrition, clothing, or home-management projects. In 1930 it was reported by 218 county extension agents that 1,707 groups with a membership of 26,892 persons, devoted the major parts of their programs to child care and training.

The goal set up by the specialists in the field is "To enable parents to create an environment in which parents and children may have optimum development in a changing civilization." The instruction gives increased knowledge and understanding of the child, and as a result more time and systematic thought are given to its training. The groups are organized primarily for mothers whose children range in age from infancy through adolescent youth. The instruction has been given largely by the group-discussion method, and has included specific assignments. Some meetings are held in the evening so that fathers as well as mothers can attend them. A series of 13 talks on child development and parent education was broadcast by the extension service of Oregon in 1930.

HOME HEALTH AND SANITATION

The educational work on health in which extension agents engage deals only with preventive health measures and with positive health. Much of this work is done in cooperation with various health agencies and health departments and is a part of the educational programs of such agencies and departments. The Extension Service has cooperated with State departments of health, especially in the preschool child-health clinics and in distributing publications on maternity and infancy.

Health and food-habit score cards have been helpful in teaching positive health standards to adults as well as to 4-H club boys and girls. In addition to proper living and food habits, complete health examinations, better care of teeth, correct posture, proper rest, and recreation have been emphasized. Evidence that the health and sanitation program has been far-reaching is found in the following report for 1930: 107,727 boys and girls were enrolled in special 4-H health clubs; 87,486 boys and girls were benefited by health-improvement and good growth and development features in the 4-H club program; 67,545 persons followed recommendations for complete health examinations; 68,987 improved posture; 162,942 reported that they had been immunized against contagious and communicable diseases; 19,946 adopted better practices in home nursing; 10,197 sanitary closets were installed; 17,664 homes were screened according to recommendations; and in 32,427 homes better methods of controlling flies, mosquitoes, and other pests were followed.

ORGANIZED MARKETING

Organized marketing was carried on in the form of egg-marketing circles, carload shipments of live and dressed poultry, exchanges, home-industries shops, parcel-post marketing, roadside stands, and curb or club markets. At such markets a large variety of products

is sold, including dressed and live poultry, eggs, dairy products, cured meats, sausage and lard, fresh vegetables and fruits, canned vegetables and fruits, jams and jellies, nuts, honey, baked goods, bulbs, cut flowers, potted plants, and other products. Extension agents have acted in an advisory capacity, giving instruction in producing and standardizing products and advising on organization and business management.

Organized marketing of farm products and crops, managed by farm women, was reported in 1930 by Delaware, Maryland, West Virginia, Massachusetts, New York, North Carolina, South Carolina, Florida, Georgia, Mississippi, Alabama, Tennessee, Kentucky, Arkansas, Ohio, Indiana, Oklahoma, South Dakota, and Montana. Sales by 29 markets in North Carolina amounted to \$273,930. One of the largest marketing enterprises that have been managed by farm women with the county home demonstration agent as adviser is the curb market at Gadsden, Ala., organized in 1923. It did a business of \$137,450 in 1930, having as many as 130 sellers on market days.

Thirty-six Maryland farm women interested in marketing made a marketing trip to New York City under the guidance of the extension service, visited the city's market terminals, and observed the grading and packing of fresh fruits, vegetables, and eggs.

A demonstration roadside market was set up during the State farmers' week in Arkansas in 1929, and demonstrations in grading, packing, and displaying were given. As a result of this demonstration, 24 women have established roadside markets in Arkansas. Similar roadside-market demonstrations were set up in connection with the Texas State farmers' short course and the Florida annual extension conference.

A study of how market money is spent by women who sell at the 28 club markets in South Carolina shows that most of the improvements made in the farm homes during 1930 were made possible by the market income. Some boys and girls went to college, and others received musical and other cultural advantages because of this extra source of family income.

HOME INDUSTRIES

Interesting and useful handicraft of high-quality workmanship, produced largely in connection with the house-furnishing project, holds a place in the home demonstration program. Women in several States have achieved such proficiency in color and design in useful and well-made articles that the articles have market value. Such articles are sold individually or by the arts and crafts associations and exchanges organized and managed by the women themselves.

An interesting and noteworthy development is the Apison rug-making industry of Tennessee. Ten years ago a few women and girls learned, under the instruction of the home demonstration agent, to make hooked rugs for their own homes. They made a special study of color, dyeing, and design. They did not go into business; they just grew into business. For nine months of 1930, in the Apison community, 100 persons, including women, girls, and men, especially ex-service men, were actively engaged in making rugs and mats;

500 rugs and 10,000 mats were made, and there were more orders than could be filled.

Perhaps the most remunerative home industry has been the production of the standardized preserved-food products put up in general utility containers or in attractive gift packages. Several Southern States have specialized in this industry. Texas reports that standardized home products are added to the market list each year. Some of the standardized food products sold in Texas in 1930 were fig preserves, strawberry preserves, sugar-coated pecan meats, grapefruit and orange marmalades, preserved watermelon products, roselle and mint jellies, fruit cakes, and steamed puddings.

These home industries are a form of expression for farm women



FIGURE 8.—A local leader instructing a group of farm women in making raffia baskets

who have creative art ability, and they have afforded a pleasant and profitable means of using leisure time. (Fig. 8.)

Another source of income to farm women is maintaining a tourist home. In West Virginia in 1930 were 11 tourist homes which measured up to definite high standards and carried the sign, "Mountain State Tourists' Home." A conference on the management of the tourist business was held under the auspices of the extension service of Vermont, the State department of information, and several chambers of commerce. Some of the subjects on the program were (1) presenting an attractive exterior, (2) making the tourist comfortable, (3) making the home restful and attractive, and (4) easy and satisfying meals for the tourists.

In New York the extension service cooperated in establishing one farm home in each of two counties as a demonstration tourist

home, with satisfying results. In the northern counties of Wisconsin a number of women are specializing in canned chicken and hooked rugs for the tourist trade.

COMMUNITY ACTIVITIES

Community achievement days, community clean-up and paint-up weeks, and organized recreation at playday events, tours, community fairs and exhibits, health clinics, and community libraries, were made successful by the united effort and cooperation of whole communities. A home demonstration club or group usually took the leadership in such activities.

The principles of landscaping used in improving home surroundings were applied to 3,552 school or other community grounds, where lawns, trees, shrubs, and flowers were planted. Groups of women who learned good principles in house furnishing and decoration extended their knowledge by improving the interiors of some of the community churches, halls, and rest rooms, and adding desirable features, such as better lights, safe and convenient entrances and steps, and kitchens adequate for serving community groups. Clubhouses and permanent camp sites to the number of 441, and 164 community rest rooms were established. Florida reported that home demonstration groups built or obtained 28 permanent clubhouses during the year.

Massachusetts, New Hampshire, Oregon, and California featured large community dinners as part of the nutrition projects. Families were invited. Live-at-home dinners, at which only home products were served, were popular county and community events in North Carolina, and 123 such dinners were held in 54 counties following one given by the governor of the State.

A community landscaping demonstration, staged in Arkansas, was one of the largest community enterprises in 1930. It included a contest in which only one community from any one county was permitted to enter. Twenty-five communities entered. In each community the whole undertaking was under the direction of the home demonstration club and its committees. General improvement was the object, and all homes of both white and colored persons were considered. Churches, schools, courthouses, stores, gins, filling stations, roadside markets, tourist camps, abandoned buildings, barns, machinery in the open, unsightly trash heaps and woodpiles, fence rows, crossroads, woods along the road, highways and roads—all were put in order or improved. The results were beyond expectation, and it is reported that the cooperative spirit developed will mean much for future improvement of these and other communities.

ORGANIZED RECREATION AND CAMPS

Recreation is no longer considered a frill on the extension program but a feature that deserves thought and planning. Farm women are taking the leadership in rural-recreation movements. Organized recreation not only helps people to become acquainted but it unifies groups so that they work better together. Women feel rested and joyful after playing games, dancing folk dances, or joining in com-

munity singing. In this frame of mind they respond better to the serious programs.

Home-talent plays as community activities were encouraged. New Hampshire and Wisconsin staged State dramatic contests or 1-act play tournaments. The contests between communities were held in the counties, and the State contest between counties was held during the State Farmers' Week. In Miami County, Ohio, two home-talent lyceum circuits with 11 communities participating were conducted.

Each year an increasing number of States are including music appreciation in their home demonstration programs and 4-H club work. Iowa and Nebraska have especially emphasized this feature. The music-appreciation project in Nebraska was started in 1925. Each month a circular is issued for the use of home demonstration clubs. The circular contains the words of 1 song to be memorized, the interpretation of some musical selection, and instructions for 1 active game and 1 quiet game. More than 20,000 circulars are issued each month. The song and game given in the circular for the month are also broadcast over the radio. In 1930 the home demonstration clubs reported 2,626 musical periods.

In Missouri 39 half-day recreational meetings, with 1,663 persons participating, were conducted by a specialist in 1930. There were 233 recreation meetings held for adolescent boys and girls. Music appreciation was part of the program of 270 clubs. Seventy-two clubs observed "music week."

The idea of out-of-door camps where farm women could rest, play, and learn materialized first in Montana, Tennessee, West Virginia, and Texas in 1921 and 1922. In 1930, 94,072 women attended 864 county or district camps in 28 States and the Territory of Hawaii. The camps provide a vacation for farm women, and such expressions as "this is the first night I have stayed from home in 10 years" are often heard in camp.

Some of the interesting program topics at the camps in 1930 were foods for summer, clothing accessories, color, shoes and feet, correct posture, personal grooming, citizenship, music appreciation, books for all ages, appreciation of good pictures, news writing, the State's history, and the native trees, shrubs, and flowers. Some of the simple handicrafts learned by the women during camp were tooling small leather coin purses, block painting on textiles, basketry, and painting and decorating magazine racks and hanging bookshelves. Such activities as hiking, swimming, spirited contests in songs and yells composed by the women, folk dancing, treasure hunts, stunts, and skits provided organized recreation and entertainment at these camps. Impressive vesper services and candle-lighting ceremonies were often held.

BOYS' AND GIRLS' 4-H CLUB WORK

In 1930 over 822,000 members of 4-H clubs voluntarily carried on demonstrations in livestock, farm crops, poultry, clothing, room improvement, gardening, foods, and the like, in their own neighborhoods. (Fig. 9.) Of these club members, 554,345, or 67.42 per cent, completed their work. These figures represent an increase of 8.81 per cent in enrollment, and an increase of 9.23 per cent in number of completions over the figures for 1929. (Table 4.)

TABLE 4.—*Enrollments and completions in boys' and girls' 4-H clubs in the United States, 1923-1930*

Year	Total enrollment		Completions		Year	Total enrollment		Completions	
	Number		Number	Per cent		Number		Number	Per cent
1923.....	459,074		249,416	54.3	1927.....	619,712		399,107	64.4
1924.....	510,355		283,283	55.5	1928.....	663,940		447,579	67.1
1925.....	565,046		329,574	58.3	1929.....	756,096		507,487	67.1
1926.....	586,156		368,305	62.8	1930.....	822,714		554,345	67.4

In 1930, 2,257 county agricultural agents reported club work with boys and 1,618 reported club work with girls. County home demon-

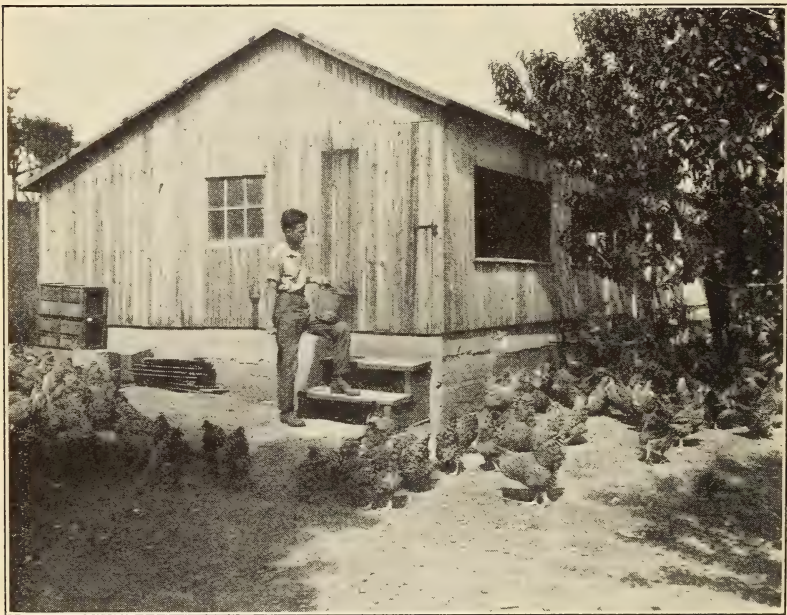


FIGURE 9.—A 4-H poultry club member with his flock of 200 Barred Plymouth Rocks and improved type of house

stration agents to the number of 220 reported club work with boys and 1,211 reported club work with girls. (Fig. 10.)

CLUB PROJECTS

Total enrollments of club members and successful completions of club projects may be used as measuring sticks of the effectiveness of 4-H club work.

Reports by all extension agents for 1930 indicated that 822,714 different boys and girls were enrolled in club projects. Of the projects started, 554,345, or 67.42 per cent, were successfully completed. Both boys and girls enrolled in each line of work, but naturally the larger number of girls chose those projects which pertained to home economics while the greater number of boys were interested in agriculture. However, the number of both boys and girls who carried

on activities relating to poultry, home gardens, handicraft, and health and sanitation is worthy of note.

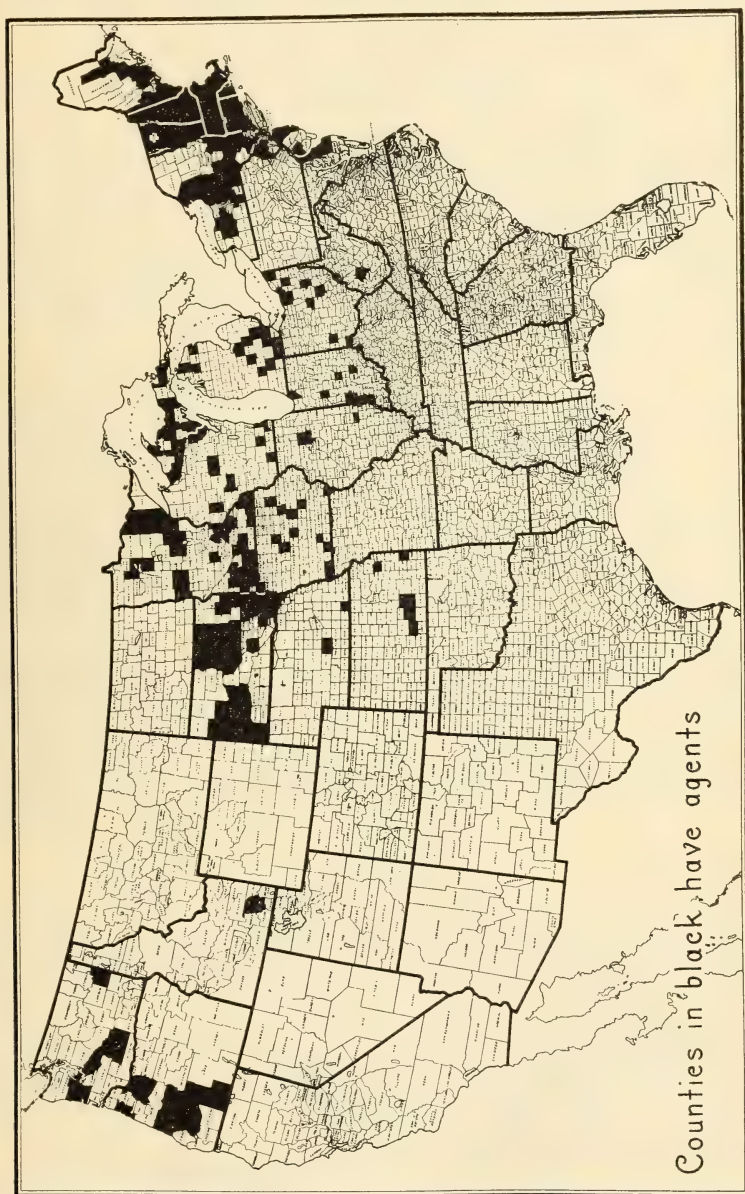


FIGURE 10.—Distribution of county club agents

LEADER CONFERENCES

The local or volunteer club leader was one of the most important persons in the supervision of 4-H club work during 1930, as in preceding years. All agents reported 85,344 local club leaders acting during the year.

County conferences provided a means of giving information to local club leaders regarding such items as program building for local clubs, methods of organizing and conducting clubs, subject matter, and the like.

State club leaders recognized the leader conference as a most effective means of increasing the volume and bettering the quality of club work in the counties. Such conferences better prepared the local leaders for their work. Some member of the State club staff or an extension specialist usually assisted the county extension agent in each conference. At these conferences, subject-matter training was given, a calendar of club activities for the year was prepared, and methods of organization were discussed. Often a good team demonstration was presented. Thus every local leader was better informed and obtained a clearer conception of the larger aspects of 4-H club work and of his part in the great extension program.

PLANS OF WORK

With but few exceptions the States reported more attention being given to making of county plans for conducting club work. These plans were usually prepared by the county club committee or council, or by a group of leaders and older club members meeting with the county extension agents and a representative of the State club staff. Making such county plans of work gave a better understanding of the whole club program to those participating in it. The States were almost unanimous in reporting that a better quality and a greater quantity of club work resulted in the counties where this method was followed.

Reports indicate that State club leaders participated more than heretofore in district conferences of extension agents. District supervisors provided greater opportunity for presentation and discussion of club work at such conferences. In a large number of States one full day, or one-half of the annual extension conference, was devoted to 4-H club work.

ACTIVITIES

ANNUAL 4-H CLUB WEEK

The reports of the State club leaders showed that all the States emphasized the importance of the annual gathering of club members at the State college of agriculture. In different States such meetings were known as 4-H short courses, 4-H round-ups, university tours, or 4-H field days. The purposes were to acquaint 4-H club members with their State agricultural colleges as well as to impart subject-matter information and to offer recognition for club achievement. In some States this annual event had grown to such proportions that district club weeks were held.

INTERSTATE ACTIVITIES

Aside from the national club camp, the principal interstate activities during 1930 centered about Camp Vail and the Eastern States Exposition at Springfield, Mass., Camp Plummer and the Pacific International at Portland, Oreg., the Tri-State Fair at Memphis,

Tenn., the National Club Congress at Chicago, Ill., and the National Dairy Exposition at St. Louis, Mo. Certain States participated in other interstate events in which but a small number of States were concerned.

PUBLIC PRESENTATION OF WORK

DEMONSTRATION TEAMS

There was a decided increase in the number of demonstration teams trained in 1930 as compared with the number trained in 1929. The total number in 1930 was 23,524. Extension agents found the demonstration team an excellent and usable method of informing the public of the work done by 4-H club members. Some States indicated that team demonstrations were considered one of the best means of teaching subject matter and also of maintaining the interest of club members. County extension agents also viewed these teams as an effective means of creating an interest in club work in sections of their counties in which no clubs had previously been organized. The fact that many more demonstration teams than judging teams were trained was worthy of comment.

JUDGING CONTESTS

Reports show that judging contests were held in connection with nearly every club project. A total of 12,533 judging teams were trained.

EXHIBITS AT FAIRS

The 4-H club work was presented at all the State fairs. Reports indicated a continuation of efforts on the part of State-fair managements to provide ample and suitable equipment for the club department.

County and community fairs again attracted 4-H exhibits, demonstrations, and judging-team contests. All these features aided in the public presentation of club work.

NEWS STORIES

The States reported using a wide variety of ways to present information on 4-H club work through the press. In most instances, the State club staff supplied the college or extension editor with information which he then prepared for syndicate, state-wide, or local distribution.

The Minneapolis (Minn.) Tribune, The Daily Huronite (S. Dak.), The Wichita (Kans.) Beacon, and The Independence (Mo.) Beacon, are but a few of the many daily newspapers which issued special 4-H club editions.

In most of the States, a column or a full page of each issue of the State farm paper was devoted to 4-H club work. Wallaces' Farmer (Iowa), The Nebraska Farmer, and The Michigan Farmer, run such departments.

Each State farm bureau paper carried either a column or a page filled with information supplied by the State club office through the extension or college editor.

Illinois, Ohio, and Nebraska, along with many other States, reported that news-writing training schools for club reporters were conducted in the counties by representatives of the extension editors' offices. These schools resulted in a large volume of news items being turned in to the local newspapers by the club reporters in the counties. Special county and State news-writing contests were reported in a larger number of States than during the previous year.

Metal road signs, placed on the mail box or gate in front of a club member's home, were reported by New York and Kansas as another publicity feature which proved worth while. It is probable that this method was used in a considerable number of States. In St. Louis County, Minn., one of these signs was presented to each club member who completed the year's work.

Certain States or counties issued 4-H club calendars, with items in the year's club program printed on the respective dates. In a number of States folders, booklets, and the like were printed for public distribution at county or State fairs and meetings of State organizations.

During the year a motion picture, of which the scenario was written by club members and the parts played by club members, was produced by a motion-picture concern in Illinois.

A considerable number of States reported making film strips and lantern slides based on their own club work.

Nearly every State made use of the printed or mimeographed County Club News issued from the office of the county extension agent. Usually these news-letters were distributed monthly to all club leaders and members and to other interested people in the county.

CAMPS

The attendance at club camps increased over that of the previous year. County, district, and State-wide camps were held. The number of 4-H camps was 2,898, with 60,371 boys and 75,313 girls attending. Much progress was evident in both the management and the programs at club camps. The Fourth National 4-H Club Camp was held in Washington, D. C., June 18 to 24, 1930, with an attendance of 238, representing 39 States.

GROWTH OR HEALTH ACTIVITIES

Nearly every State reported more and more attention being given to development of programs directing attention to the health "H" in club work. In most States health activities supplemented the usual club projects, but definite health projects were organized in a few.

MUSIC

During 1930 more attention was given to music in 4-H club work than had been given during any previous year. Music-appreciation and music-memory contests were continued, and more 4-H club orchestras, bands, and chorus groups were organized.

Missouri continued its song-writing contest which is sponsored by the State home demonstration agents' association. Out of this contest came the official State 4-H club song. Mrs. Harriett F. Johnson,

State girls' club agent in South Carolina, wrote and published in sheet music form a club song entitled, "The 4-H Clover and the Rose." This song was introduced during the national club camp in 1930.

RADIO

Leaders and members of 4-H clubs have been quick to recognize and use the opportunity which the radio provides for extending the influence of 4-H club work. During 1930, efforts to provide better radio programs were continued. Throughout the year, the United States Department of Agriculture and the State colleges cooperated in the national 4-H radio program broadcast on the first Saturday of each month. Mississippi reported that 42 counties used these radio programs regularly for club community meetings.

In Florida, Minnesota, Nebraska, South Dakota, Oklahoma, Oregon, Iowa, New York, Connecticut, Kansas, Michigan, Wisconsin, and other States, 4-H club programs were broadcast regularly from stations within the States.

RECOGNITION FOR CLUB MEMBERS

In various sections of the country, efforts were made to provide recognition for outstanding 4-H club members by means of organizations formed for that purpose. Michigan and Connecticut reported 4-H Service Clubs; Kansas reported the Who's Who Club; Maryland, West Virginia, the Carolinas, and other States continued the All-Star Clubs; Massachusetts designated its organizations as "Junior Directors" and "4-H Alumni Clubs"; and Vermont chose the name of "State 4-H Honor Society." In Rhode Island, the organization was known as the "Counselors," and Delaware reported a similar group.

EXTENSION WORK WITH NEGROES

Negro farmers in the South receiving extension assistance made consistent progress in 1930 in improving their economic condition. They learned to diversify their crop production intelligently, to market their produce more advantageously, to raise livestock more profitably, and to improve and beautify their homes. (Fig. 11.)

Fortunately for the negro farming people and the agents who work among them, both take readily to the demonstration idea; in other words, the negro farm family delights in a practical application of subject matter, whether it is mixing fertilizer, adjusting a plow, setting up terracing machines, pruning trees, making hats, remodeling furniture, making rugs, or framing pictures.

AGRICULTURAL WORK

Instruction was given in the following lines of agricultural practice: Agronomy, animal husbandry, poultry, dairying, animal diseases, horticulture, plant pathology, agricultural engineering, farm management, and marketing. Extension workers found the average negro farmer willing and eager to be taught better methods. This was true of both tenant and landowner.

What negro farmers accomplished in 1930 as a result of extension influence is shown by the results obtained by individual farmers

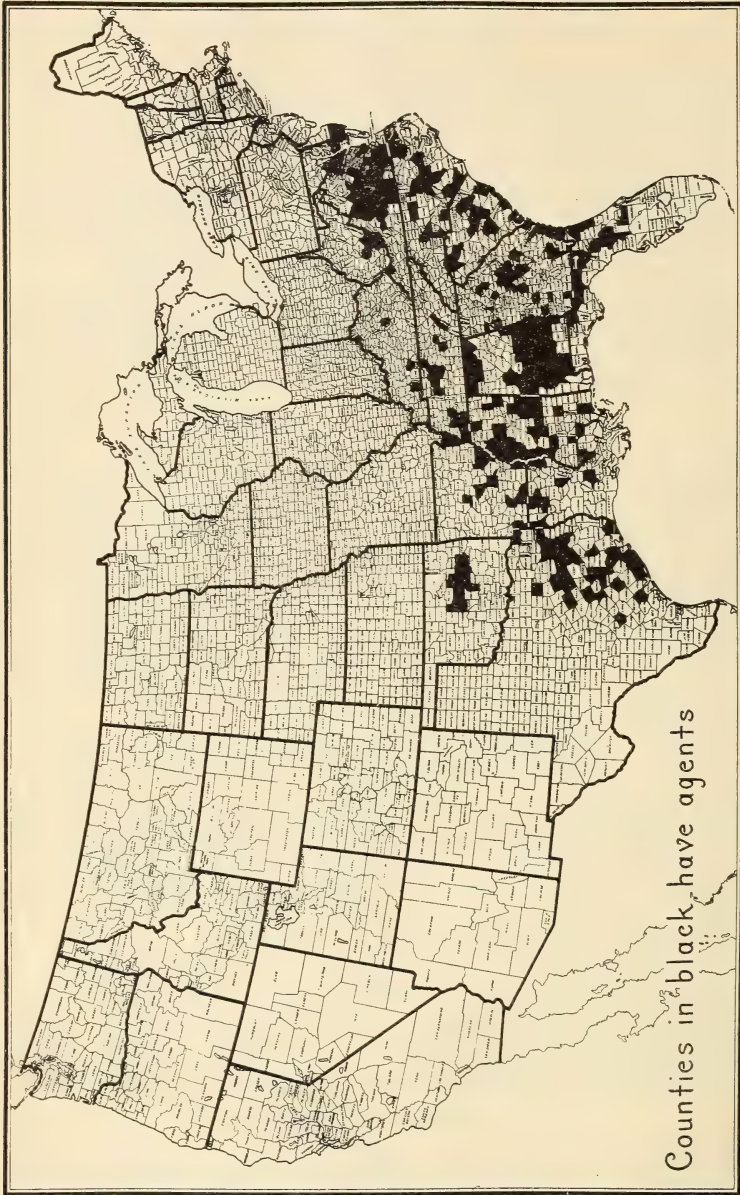


FIGURE 11.—Distribution of negro agents in counties

and by groups of men and women in communities where the work was carried on.

The old idea that negro farmers in the South, schooled in cotton growing, could not be depended upon to take care of cows, has become

obsolete. Reports similar to the following have come from practically every State where negroes work. Agent A. W. Roper, of Lowndes County, Ala., states:

The dairy industry with the colored people of the county is growing in a very encouraging way. Calhoun has been one of the new sections to start selling sour cream. Through a company in Montgomery, Ala., we succeeded in getting a testing outfit. In the Span Place community, 20 farmers with 176 cows averaged \$696 in monthly sales. In Burkville community, 19 milkers with 175 cows had a monthly average return of \$1,030. These two communities sold dairy products to the extent of \$15,334 in nine months. The total milk sales by the colored farmers of the county for the past four years were as follows:

1927-----	\$30,000
1928-----	60,000
1929-----	90,000
1930-----	54,800

Farland Sharpley, of Morgan County, Ala., made this report:

I sold \$236.50 worth of milk and butter this year (1930), selling one and two times a week at the Decatur curb market, and occasionally at Harteselle. I got 20 cents a gallon for buttermilk and 40 cents a pound for butter. I milked three cows, two of which calved early in the spring. I fed cottonseed meal, hulls, and soybeans. The cows were kept on a Bermuda-grass pasture. The feed I bought amounted to only \$36, leaving a profit of \$200.

State Agent M. M. Hubert reports on dairy activities in Mississippi. Speaking of the Borden Condensery at Starkville, he says:

The price paid for milk during the month of April, 1930, was 47 cents per pound for butterfat. A total of \$30,000 was paid out during that month. Approximately 47 per cent of this went to negro patrons.

Sam Williams, a farmer of Clarendon County, S. C., under the supervision of County Agent William Thompson, completed a remarkable demonstration with hogs. From a litter of 10 pigs, managed correctly, he fed out 2,035 pounds of pork in 152 days. The pork sold at 9½ cents per pound, bringing him \$193.32. With this money he was able to pay his fertilizer bill. His success with another litter a few months later earned him enough money to pay his rent.

Recently A. C. Johnson, of the same county, made a litter of 10 pigs weigh 1,880 pounds within 180 days and earned \$186.02. Silas Walker, of the same community, with a litter of 9 pigs, fed out 1,770 pounds of pork within 180 days. The pork sold for \$169.61. These demonstrations were conducted with the advice of the agent. None of these farmers applied for Government aid during the drought. (Fig. 12.)

Murphy Robinson of Lowndes County, Ala., carried out a corn demonstration under the instruction of the county agent. His story follows:

My corn was grown on hammock land, well drained so that the water never stood on it to damage the corn. I bedded the land on the last day of January with a 2-horse plow. On the 17th I ran a 16-inch sweep. I followed this with my seed corn. I then bedded on the corn with a 2-horse plow. I pulled the bed down with a harrow.

The corn came up to a perfect stand. When it was 8 inches high, I thinned it out to 20 inches apart, one stalk to a hill, and plowed it again. When it was 20 inches high, I side-dressed the corn with 75 pounds of nitrate of soda to the acre. I plowed it again after this, making a total of three plowings. When plowed the last time, it averaged 4½ feet high.

From the 2 acres of land I harvested 136 bushels of corn, which is more than I usually get on 6 acres. The sale of this corn brought me \$136. The cost of

production, including rent of land, labor, and fertilizer, was \$31, leaving me a net profit of \$105 on the 2 acres.

There is no question that the farm bureau in the South has played a larger part in aiding negro county agent work (where it has been given a fair trial) than any other single agency. The benefits which the negro farmer is deriving through this organization are far-reaching.

Never before has any organization invited negro farmers to share, equally with white farmers, the benefits in marketing farm commodities through buying and selling; and it is gratifying to note the response from large numbers of negro farmers. Reports from Alabama, Louisiana, and Arkansas indicate that an increased number joined in 1930, and all are satisfied. This shows what benefits may



FIGURE 12.—A negro farmer with his demonstration herd of swine

be derived from building up community spirit, breaking down the barriers of race prejudice and suspicion, and arriving at a better understanding between the two racial groups.

As soon as A. A. Hicks, county agent, Clarke County, Ala., found that the Federal money for the drought-stricken region was available, he made an effort to see that the colored farmers were benefitted. Negro farmers borrowed \$2,750 of the total appropriation of \$7,500. Agent Hicks, because of his efficient service, has been appointed a member of the county drought-relief committee with the task of keeping the white members of the committee informed on the condition of the colored people.

HOME DEMONSTRATION WORK

As the negro agricultural agents have succeeded in promoting better farm practices by men and boys, so have negro home demonstra-

tion agents aided in improving rural home conditions. The reports of home demonstration agents show an encouraging increase in the number of new or remodeled homes during the year. These homes represent almost a revolutionary change in living conditions. Women received extension instruction in clothing, food preparation and preservation, child welfare, and health and sanitation.

Probably no factor has contributed more to the unrest of farm families than unsightly, poorly arranged, and uncomfortable homes. In such environments women can not be happy and children can not be expected to become the highest type of citizens. Extension workers find that grown-up boys and girls often leave home because they become tired or ashamed of the poor environment.

The chief problems confronting the negro farm family to-day, are, generally speaking, those of food, clothing, and shelter. Lack of interior equipment to insure comfort in the home, unbalanced diet, and insufficient sanitary protection are phases of these problems. Other problems are lack of recreational facilities, and poor schools. Extension effort was systematically directed in 1930 toward solving these problems which, in a large measure, have arisen from a desire on the part of the people themselves for a higher standard of living.

Much of the credit for the development of the live-at-home program in extension service is due to the farm women and girls for growing and marketing vegetables and small fruits, caring for the dairy cow, selling milk and butter, caring for poultry, and marketing chickens and eggs.

Reports indicate that many farmers working under demonstration methods completely avoided debt and other privations in 1930 by giving more attention to the so-called "side lines," thereby enabling themselves to make the main crop without borrowing money.

FOODS AND NUTRITION

Commenting on the year's work, the Macon County, Ala., home demonstration agent says:

Our meetings are held from home to home. This method has its advantages. No woman likes for visitors to find her home disorderly. A club meeting at a home means that the house and yards are going to receive a thorough cleaning; for cleanliness is a strong point in the club. The meeting in the home also affords the housewife an opportunity to show off her accomplishments—her canned and preserved fruits and vegetables, rag rugs, made-over garments, or perhaps her new chicken coops, to the admiration of her fellow club women.

The program for the year is hinged upon one great need—the improvement of the family diet. The prevalence of pellagra bespeaks the need of variety in the everyday diet of the people. Though the farmer has the best foods at his command—milk, butter, eggs, and vegetables—they are too often improperly cooked and poorly served.

Along with this program for the improvement of the family diet, lessons have been given in poultry raising, egg preserving, butter making, and soap making, as well as demonstrations in home conveniences, such as fireless cooking, scrubbing traps, stocking mops, and bread mixtures. Demonstrations have also been given in home beautification, sanitation, and such homely subjects as laundering, house cleaning, and dyeing, cleaning, or making over old garments. Many dollars are saved to individuals when they know how to make an old serge suit into a 1-piece dress or an old cloak into a child's winter coat.

The most effective demonstration work done in Macon County from a monetary point of view, was the establishing of a curb market. Twenty-nine club

women, representing six communities, received \$1,009 for their surplus garden and poultry products. The first market day was held the last of June, with 8 persons selling and 16 varieties of products offered. The market ran three hours a day, two days a week, averaging an hour for each work day. One club member reported having made \$136 in three months' time. This was more than three bales of cotton brought, and it required six months to produce the cotton.

INCREASED INCOMES

The Morgan County, Ala., home demonstration agent says:

The sum of \$1,512 came to the farm folks of the county this year from the Decatur curb market. Mrs. Julia Davis, of Nebo community, sold \$422 worth of produce. Mrs. Mattie Tate, of Cedar Lake community, reports \$319 gained. These women, like other sellers, were not able to lift any mortgages this year, but they did pay taxes, insurance, and grocery bills and keep the children in school.

The State home demonstration agent for negro work in Florida reports:

It is the aim of home demonstration agents to teach the country housewife how to live frugally on what she has, how to nourish the body, and how to balance a ration for the sake of economy and health. As the result of the efforts of seven negro home demonstration agents, 1,012 women were enrolled in home makers' club work and realized from the sale of butter and poultry the sum of \$5,589.

Similar results were reported from hundreds of communities in other sections of the South. Ten negro home demonstration agents in Texas report having carried out 11,328 garden demonstrations, supervised the canning of 223,087 jars of fruit and vegetables, saved 60,000 pounds of pork, made 3,460 pounds of sausage, 5,200 pounds of lard, and 3,510 pounds of headcheese, put up 527 gallons of vinegar, and dried 439 pounds of fruit, at an approximate saving to the farmers among whom they worked of \$31,500. This work was all done in one season, and before the advent of extension service such practices were unheard of. (Fig 13.)

HEALTH AND SANITATION

The home demonstration agent in Amherst County, Va., reports that her county is continuing the work of the state-wide sanitation campaign and that 28 toilets were built in and around Amherst, the county seat. Every public school and nearly every church now has two sanitary toilets. Rural home owners are also building toilets according to the State plan.

The screening of windows, inspired by the farm and home demonstration agents, is a great factor in making farm homes more comfortable and in making farm kitchens cleaner places in which to prepare the family food. A farm woman in Virginia said:

I didn't know that I could be so comfortable in a screened house. Now, I can go to sleep in any room in my house with no flies to bother me. I can work all day without having to fight flies, to say nothing about keeping them out of the food. My rooms were whitewashed last summer, but you can't see any flyspecks. I do not see why I waited so long for this comfort.

One of the most valuable adjuncts to home demonstration activity in Alabama for the last three years has been the work of a public nurse who travels over the State with the movable school and the

home demonstration agents, teaching practical sanitation and organizing rural health clubs in connection with regular organizations perfected by extension agents.

4-H CLUB WORK

The main projects carried on by negro 4-H club boys and girls in the South in 1930 were, for boys—cotton, corn, sweetpotatoes, potatoes, tobacco, soybeans, velvetbeans, oats, peanuts, strawberries, truck crops, hogs, poultry, and dairy cattle; and for girls—foods, clothing, millinery, home improvement, poultry, and gardening. Wherever 4-H club work has been introduced among negro boys and girls, they have taken hold with a zest unequaled in any other division of the work.



FIGURE 13.—A negro home demonstration agent demonstrating improved canning methods

Reports show that scores of boys and girls have made enough money from their club projects to pay their tuition at school, and many have substantial bank accounts. Public-spirited bankers and others have subscribed readily to prizes and awards for efficiency in club work. Such awards have included trips to State and interstate contests. Aside from receiving financial gain from their club projects, the 4-H club boys have been schooled in scientific agricultural practice such as properly preparing seed beds, properly applying the right kind of fertilizer, using well-selected seed, properly cultivating crops, and properly selecting, feeding, and caring for livestock.

In carrying out their projects, the girls have been drilled in the technic of good housekeeping, table setting, serving meals, launder-

ing, bed making, hanging curtains, framing and hanging pictures, renovating, and ridding homes of household pests.

Another outstanding example is given by T. M. Monan of Jones County, Miss.:

My communities are federated into a county organization. Early in the year, a county-wide meeting was held to outline a program of work for adults and juniors in the county. In this meeting the fact was revealed that there were several boys who were anxious to do 4-H club work, but had no way of financing their projects. I went with the officers of the county organization and conferred with a representative of the Commercial Bank at Laurel, Miss. An agreement was reached by which 46 boys were financed by this bank. Every one of them made good. Thirty-five of these boys averaged one bale of cotton per acre. George Johnson, of Moselle, Miss., took the lead in this work, using 1,000 pounds of fertilizer on his acre and harvesting 2,100 pounds of cotton. Drewell Currie came second with 1,800 pounds. On October 24, the 46 boys went, in a body, to the Commercial Bank and settled their accounts in full from the proceeds of their projects, and all of them had money left.

PROGRAM BUILDING

The methods followed in building programs for negro extension work are necessarily flexible. At all times an effort has been made to conform to local conditions. Groups of farmers are called together in their own communities and are consulted as to their needs. The needs are listed and on them as a basis certain projects for the year are planned and all farmers agree to work toward the goals which have been chosen. The community plans are combined into a county program; and after district and State meetings of county and home demonstration agents, the supervising agents make up a State plan of work. Of course, in some States there are exceptions to this rule. When it is considered that a large percentage of negro farmers are tenants living upon plantations, who have always looked to their landowners to make the yearly "arrangements" for them, it can readily be seen why program building is a slow process. There was a growing tendency in 1930 on the part of the white landowners, those living on their farms and those classed as "absentees," to welcome the services of negro extension agents in working out plans calculated to change the "advance system" to a cash system.

There is a marked improvement in the correlation of the agricultural agents' programs with those of the home demonstration agents among negro extension workers. In the past there has been considerable criticism to the effect that the agricultural agents and home demonstration agents, working in the same counties, were operating too independently of each other. Observation made on field trips throughout the territory, shows that there is less ground for this criticism now than formerly. A more cooperative spirit is gradually being built up between the two groups, while directors and supervisors of the work are insisting that the two agencies combine their efforts.

MOVABLE SCHOOL

The movable school has been very successful in creating interest among groups of farmers. It has proved a blessing in molding interest in more food production, more and better gardens, more poultry, better preparation of food in the home, preservation of fruits and vegetables, better homes, and sanitation. The simple and practical

demonstrations at such schools stimulate the interest of the negro farmer in his home and strengthen his attachment for it, even though he may not own it. The schools also stimulate the desire of the tenant to own property; they cause the country woman to learn practical lessons in thrift and more industrious habits in home making. The movable schools furnish a splendid opportunity for the people to do things for themselves, instead of letting the agents do the work for them.

NEWS SERVICE

Negro agents were unusually successful in keeping the results of their work before the public in 1930. Local papers and dailies readily printed items on successful achievements in negro extension work. Many of these items were asked for by the representatives of the papers. Representatives of business, religious, and civic organizations inspected and joined in demonstrations of successful farm and home club activities carried on by negroes. In some instances, sentiment in favor of extension work among the negroes was developed through the press to such an extent that agents were retained in the service in the face of local opposition that threatened to cause the extension work to be discontinued. A few negro agents have prepared pamphlets and magazine articles which have been accepted by publishers and the public.

COOPERATING AGENCIES

Negro extension workers under the Smith-Lever Act enjoyed cordial relationships with other agencies doing similar work, such as the Smith-Hughes teachers. There was little friction or misunderstanding between these two groups. Workers in both departments realized that the field is broad enough for them to work effectively without chance of duplication. In most States the Smith-Hughes and Smith-Lever employees are graduates from the same schools, a condition which naturally facilitates personal friendship and interest.

The negro extension service continued to enjoy a happy connection with State and county educational systems. This was evident especially in local club work. Many of the pupils were 4-H club members. The reports indicate that an increasing number of rural school-teachers are serving as club leaders and supervisors, especially in home demonstration activities. The home demonstration agents are of material value in assisting the teachers with their nutritional work, such as serving hot lunches, as advocated by educational departments. They have splendid cooperation in the matter of rural health and sanitation. County and State health departments have relied heavily on the negro extension service, recognizing that it offers a medium for making contacts not otherwise possible, and thereby furthering sanitation in schools and the homes of negro farmers.

A few States are employing negro nurses who work with the extension agents in child welfare and in combating major diseases, such as tuberculosis, typhoid fever, malaria, hookworm, pellagra, and venereal diseases, all too prevalent among rural people. Through

such cooperation, the extension service program is gradually being developed to a higher degree of effectiveness than would have been possible without the assistance of these other organizations.

Negro extension work could not have made such rapid progress without local support, such as that given by bankers, merchants, chambers of commerce, churches, and fraternal organizations. Banks have gladly financed negro boys and girls in their poultry, dairy, and pig projects. Without this aid these boys and girls could not have purchased their stock and equipment. Other organizations have given prizes to encourage better work among farmers and their children. These prizes have consisted of money, trips, camp expenses, medals, and other awards.

TRAINING OF AGENTS

In 1930, more negro extension agents than ever before availed themselves of the opportunity to study. A few have received academic degrees through periodic study since entering the service. A large number stationed near accredited institutions are attending night and summer schools. Through the influence of Federal and State officials, the whole group of men and women employed was this year granted a month's leave of absence for intensive study, made possible through the Rosenwald Fund, which also granted 20 scholarships for training supervisors of farm and home demonstration agents, and in agricultural economics. The winners of these scholarships are now in school on a year's leave of absence.

During the last three years the negro land-grant colleges have strengthened their courses in agriculture and home economics to meet the urgent demand for farm and home demonstration agents. Some of these schools are sending their upper-class students into the field to work with extension agents, and giving them full academic credit for such work.

The State agent for negro work in Alabama describes the system of introducing negro agents to their work.

Before a new agent is placed in a county, he is required to come to headquarters, where every phase of the program of work is gone over in detail. He is then assigned to the movable-school force for a given period. There he learns how to make contacts with local people and how to demonstrate by seeing and helping others. We find that this method gives the new agent a clear insight into his duties. All vacancies and new positions are filled in this manner.

For the general improvement of all agents already in service, we hold sectional meetings at least twice a year, including a 10-day short course. During this course we bring before them specialists from the department at Washington, Tuskegee Institute, and the State agricultural college at Auburn, to give demonstrations and lectures on the extension program. It is in this way that we try to keep the agents well informed.

The valuable information received by agents through short courses and summer schools has led to the use of new and more practical methods of instruction.

PERIOD OF SERVICE OF AGENTS

The period of service among negro agents is lengthening. This change is attributed in part to the raising of academic standards and the consequent better preparation of agents, and in part to the prom-

ise of better salaries, which enables the agents to look upon the extension service as a life work, and not as a temporary occupation. Many agents find that the extension service offers opportunity to pursue higher studies and other means of self-improvement. The home demonstration division of negro work still faces the problem which arises when the agents marry. Probably this problem can be solved only by employing older and more settled women. This plan, of course, would run counter to the general policy of not employing married women. The turnover in all branches of the service has been perceptibly reduced, and this condition makes the work more secure.

FARMERS' INSTITUTES

During the fiscal year ended June 30, 1930, farmers' institutes were officially conducted as state-wide activities in nine States. This number of States is two smaller than the number for 1929, which in turn was two smaller than the number for 1928.

Considering the amount of money contributed by the Federal Government for cooperative extension work in each State, and the State offset funds and county and private contributions, it is surprising that in 1930 in Iowa, farmers and others in the neighborhoods where institutes were held, contributed \$23,109.79 to this work. This is \$5,360.93 more than they gave in 1929, and about three times the amount of the State appropriation of \$7,771.54 for farmers' institutes. Likewise, in Indiana, the State appropriation of \$13,704.85 was augmented by private contributions of \$19,456.07, nearly one and one-half times the State fund. Private donations of \$4,825 in Illinois and \$15,400 in Ohio, supplemented the large appropriations of those States for farmers' institutes. These instances show that in these four States at least, many farmers believe they are getting from the institutes some benefit not provided by other and newer phases of extension work.

No new developments or changes occurred in the conduct of farmers' institutes during the year. The extension division of the college of agriculture now has complete charge of farmers' institutes in each State except Iowa and Maine, where this control is vested in the State department of agriculture, and Illinois, where a State department of farmers' institutes conducts all such activities. These three exceptions, however, do not cause duplication of effort or a distinct or independent line of instruction, since each authority cooperates, and is closely correlated, with the organized extension service at the college of agriculture and with the agricultural, home economics, and club agent work in the counties, simply supplementing, reenforcing, and supporting the activities of these agencies.

INSTITUTES CONTROLLED THROUGH STATE DEPARTMENTS

In the three States where farmers' institutes are directed and managed by State departments 579 institutes were held covering 884 days, with 1,968 sessions attended by 272,274 persons. The instruction was given by 394 persons, of whom none was specifically reported as a member of the extension service, 35 were from experiment-station staffs, 2 from State departments of agriculture, and 11 were farmers and farm women engaged for this purpose because of noteworthy ac-

accomplishments on their own farms or in their own homes. The total cost of these institutes was \$69,195.52, of which sum special State appropriations provided \$41,260.73 and \$27,934.79 was contributed by farmers and others in the neighborhoods of the institutes.

In comparison with the previous year's reports of farmers' institutes conducted by State departments, the reports for 1930 show an increase in the number of institutes, attendance, and amount of money expended, but a decrease in the number of days and of sessions held.

INSTITUTES CONTROLLED THROUGH COLLEGES OF AGRICULTURE

The six States conducting farmers' institutes under the direction of their colleges of agriculture held a total of 2,005 institutes which lasted 2,868 days, comprised 6,601 sessions, and were attended by 997,145 persons. They employed 259 instructors of whom 59 were members of the extension force, 15 from experiment station staffs, 9 from State departments of agriculture, and most of the remaining 176 were farmers and farm women engaged only during the institute season. The cost of these institutes was \$106,813.27. Of this amount, \$71,156.14 was derived from State appropriations for the purpose, and \$35,657.13 from other sources, mostly local contributions by farmers and others near the meetings.

In comparison with the previous year's reports of farmers' institutes conducted by the colleges of agriculture, the reports for 1930 show a slight decrease in the number of institutes, days occupied, attendance, and money expended, but a slight increase in the number of sessions.

STATES HOLDING FARMERS' INSTITUTES

The nine States conducting farmers' institutes held a total of 2,584 institutes extending over a period of 3,752 days and comprising 8,569 sessions attended by a total of 1,269,419 persons. The instruction at these institutes was given by 653 persons, of whom 59 were members of the extension force, 50 were from experiment-station staffs, 11 from the personnel of State departments of agriculture, and 187 from other sources. Those from other sources were principally farmers and farm women engaged only for the institute season. They were selected because of their success and their reputations for having actually accomplished certain things on their own farms or in their own homes, under actual farm and farm-home conditions, as well as for their ability to tell others how they accomplished those things. Farmers have confidence in such instruction and are likely to appreciate it. They are more likely to put into practice the teachings of such persons, believing them to be more practical than those of college or extension workers. The cost of these institutes was \$176,008.79, of which \$112,416.87 came from State appropriations for farmers' institute work and \$63,591.92 from local contributions.

In comparison with the previous year's reports of farmers' institutes conducted by both State departments and colleges of agriculture, the reports for 1930 show a slight decrease in the number of institutes held, days lasting, and sessions held, but a slight increase in attendance and in money expended.

Farmers' institute work differs in quality as well as in quantity in the several States. A detailed statement of the number of farmers' institutes conducted and the extent of their work during the fiscal year ended June 30, 1930, will be found in Tables 11 and 12, in which States are grouped according to the two sources of management.

SPECIALISTS' ACTIVITIES

INTRODUCTION

There were employed in the States in 1930 a total of 1,234 subject-matter specialists representing 22 projects. Working with them were 17 specialists representing 8 different bureaus within the Department of Agriculture.

During the year the following full-time workers were added to the group of Federal subject-matter specialists representing the Bureaus of Dairy Industry, A. B. Nystrom, Central States, and R. C. Jones, Western States; Public Roads, S. P. Lyle, extension engineer; and Entomology, M. P. Jones, Eastern States, and Fred D. Butcher, Central States.

The weekly conferences of extension workers in the Department of Agriculture continued with increased interest and attendance. A few outstanding subjects discussed were: Methods of Disseminating Outlook Material, The Ethylene Process of Coloring Fruits and Blanching Vegetables, Licensing of Fruit and Vegetable Dealers, How the Federal Government Assists the State Agricultural Colleges, Administration of the Pure Food Laws, Commercial Aspects of National-Forest Work and Their Application to Extension, and Immigration and Its Effect on American Agriculture. The purpose of these conferences is to acquaint the extension workers in the Office of Cooperative Extension Work with the other work of the Department of Agriculture. They are also intended to bring out suggestions from the extension administration group as to the adaptability of the work to the field.

Members of the specialists' group assisted in preparing visual teaching material, such as lantern slides, motion pictures, charts, and photographs to be distributed or lent to State extension services. They also stimulated interest in writing 1-act dramas, pageants, radio programs, and various other forms of teaching material originating principally in the States.

The specialists cooperated with one another and with the extension subject-matter specialists in the States in giving a greater economic content to their discussions and to the demonstrations. They also assisted in the economic conference conducted by the department and in the dissemination of outlook material. They accompanied persons from the administrative groups of the Office of Cooperative Extension Work who went into the field to assist in developing community and county programs of work in cooperation with State extension workers.

The severe drought in the Central and Southern States led many Federal workers to devise plans, in cooperation with the States, for emergency work, especially in nutrition, agronomy, farm management, home management, and animal husbandry; and because of the

general agricultural depression of 1930 many of the efforts of these workers were directed toward lowering the cost of production.

AGRONOMY

There was little change in the extension agronomy program in 1930, the work dealing very largely with seed improvement and the production of feed crops.

The work on feed crops was of great importance, especially in the States seriously affected by the drought. Normally, the feed program deals primarily with pasture improvement, feed grains, and forage crops. However, in the States affected by drought, the extension agronomists played an important part during the summer and fall in bringing about the planting of emergency feed crops, especially forage crops and emergency pastures, to carry livestock through the fall and winter and in making plans for the planting of emergency pasture and feed crops for the spring.

The work with legumes was seriously affected by the weather; in many States almost all the standard legume seedings, such as those of alfalfa, sweetclover, and clover, were lost. The two outstanding legumes that survived the drought were the soybean and the Korean Lespedeza in Kentucky and Tennessee.

The soybean proved its real value under adverse conditions, and was almost the only hay crop left on many farms. However, there are definite limits to the quantity of this crop that can be used, since at the present time there are only three principal uses for soybeans—for hay, for seed, and for vegetable oil.

Korean Lespedeza made a good showing in the drought areas of Kentucky and Tennessee. Reports from Kentucky state that all but two counties carried on some work with Lespedeza, and Korean Lespedeza stood out as being the hardiest, especially in the drought areas. It produced a fine hay crop of good quantity, and also a reasonably heavy seed crop.

Seed improvement continued to be one of the most important projects in agronomy, as it is the basis of all crop improvement under a well-organized agronomy program. In a number of States, advantage was taken of the drought to get farmers in many sections to use improved or certified seed for the first time. Many farmers who usually save their own seed were forced to purchase seed for the 1931 crop, and by taking advantage of this situation in time, the extension agronomists, cooperating with the seed-improvement associations, were able to furnish these farmers with the best seed available in the State, and at prices that were reasonable.

Reports indicate that some phase of seed-improvement work was carried on in 42 of the 48 States. Only six States, Connecticut, Massachusetts, Rhode Island, Vermont, Mississippi, and South Carolina, report no seed-improvement work, but Mississippi is planning to develop a seed-improvement program and a seed-improvement association. The first four States mentioned are seed-consuming, rather than seed-producing, and depend upon outside sources, principally New York, New Jersey, and Pennsylvania, for their seed supply.

The real value of the seed-improvement program is coming to be recognized more and more by the colleges, extension service, and

commercial seed trade. The associations are becoming better organized, their work is being correlated among States of the same section, and during the next two or three years there will probably be well-organized seed-improvement associations in all the important crop States. Three or four States, principally in the South, are developing the seed-improvement work, looking toward the organization and the control of soil erosion.

Weed-control activities are developing rapidly in spite of the small amount of investigational work being carried on. Many States have come to regard the use of chemical weed killers as an important supplement to good cultivation, rotations, and better cultural methods in the control of weeds. The cost of these chemical weed killers, and the lack of information on the best methods for their use, are retarding development in this phase of the agronomy work.

During 1930, agronomy work was carried on in 44 States by 113 specialists in soils and crops, of whom 12 devoted only part of their time to the work. Twenty-two States had 1 specialist each, 7 States had two specialists, and the remaining 15 States had 3 or more, the largest number employed in any one State being 11 in Michigan. No agronomy specialists were employed in the Territories of Alaska, Hawaii, or Porto Rico.

SOIL IMPROVEMENT

The soil-improvement work continued along the lines of developing better use of high-grade commercial fertilizers, the use of lime for soil improvement, the production of legumes and green manures, and the controlling of soil erosion.

Economic conditions caused a tendency to spend less money on fertilizers and lime, and in many States the extension agronomists assisted in developing programs whereby the farmers were able to get the most plant food for the least money. This was accomplished by developing cooperative buying of commercial fertilizers and the use of high-analysis fertilizers, making possible the purchase of larger amounts of plant food per unit of cost.

The lime programs in a number of States were not carried on so vigorously as in other years, partly because of economic conditions and partly because many States with the strongest lime programs were severely affected by the drought which not only decreased the income of the farmers, but also in many cases destroyed the new seedlings of legumes, so that not nearly so much lime was used during the summer and fall as ordinarily. The work in Illinois is a good example. In 1929 approximately 900,000 tons of lime were reported to have been used in the State; in 1930 563,677 tons were used. The decrease was due, not to a smaller amount of work having been done on lime, but to economic and other conditions affecting the legume crops.

Encouraging the use of green manure continued to be an important phase of the program, especially in the Southern States, where progress was made in the use of vetch and Austrian winter peas as winter cover crops to be plowed down for green manure.

Work in soil conservation such as terracing and moisture control, has not received the attention that it needs. This activity is important in a number of States. Such States as Oklahoma, Texas, and

New Mexico are giving much attention to it. In many sections this is one of the most important projects and is the basis of the entire soil program. Without control of moisture and soil, not only is the moisture necessary to crop production lost, but in a few years almost the entire supply of available plant food and organic matter in the surface soil is lost.

HORTICULTURE

Home-landscape improvement and home-garden work led all other activities in growth in 1930. The home agents are carrying on a large part of the work in both lines. Many county home agents have 100 or more home-improvement demonstrations, and some have as many as 300 garden demonstrations. Vegetable work is expanding, and several new positions were filled during the year in order to handle this growth. Fruit work is growing, and nut work is holding its own. The 4-H club projects have made some increase. Some State federations of garden clubs are bringing landscape improvement to hundreds of homes in cooperation with the landscape specialists. Several States employed landscape specialists in 1930 for the first time.

The lines of work were much the same as those of the previous year, with a trend toward more cost accounting and economics. One of the newer lines was that with greenhouse crops, particularly in Ohio, Pennsylvania, and Connecticut. Home gardens and home landscaping are demanding more attention than anything else. The use of contests in these two activities has multiplied the number of demonstrations. Changing to the best varieties of commercial apples in the New England States is accomplished by top-working trees of undesirable varieties, and the same method is used in changing to better varieties of pecans in the Southern States. The use of bees in orchards to cross-pollinate blossoms has been proved financially profitable, and is a recognized practice in many orchards. Pruning, spraying, fertilizing, cover cropping, fruit thinning, fruit washing, grading, and packing are other leading lines. Orchard spray rings are increasing rapidly in some sections.

In vegetable work the lines outstanding in growth and results are plant growing in glasshouses, use of certified seed and improved varieties, earlier planting of tomatoes for the cannery, insect and disease control, use of fertilizers, standardizing grades and packs, improved marketing methods, and growing home gardens.

The principal lines of work with nut crops are fertilizing and use of cover crops, cultivation, pruning, top-working of poor varieties and seedlings, and disease and insect control.

Landscaping extension is growing rapidly and includes the beautification of homes, schools, churches, courthouses, parks, cemeteries, auto camps, and county and State highways.

The spray services usually are carried on in cooperation with experiment-station or extension entomologists and plant pathologists. At different points in each State where a spray service is maintained, observation points are established and at these points the emergence of insects and the development of diseases are watched, so that fruit growers may be warned when it is time to spray. The warnings are telephoned or telegraphed to county agents, Smith-Hughes teach-

ers, chambers of commerce, bankers, or to other agencies which relay the information to the fruit growers. Well-developed spray services are maintained in Maryland, New Jersey, New York, Pennsylvania, Iowa, Wisconsin, Kansas, Michigan, Virginia, Arkansas, Kentucky, and Ohio.

Extension schools are growing in popularity and are among the best means of getting horticultural information to people who need it. Pecan schools are popular in Arkansas, Texas, and Oklahoma; grading and packing schools in Ohio; orchard schools in Wisconsin and Michigan; landscape and orchard and garden schools in Iowa; orchard and garden schools in Oregon; and canners' schools in Maryland and Arkansas. Pennsylvania had 121 tree-pruning schools, and Kansas had 97 schools in gardens and nutrition.

In practically all States cover crops are grown as a means of soil improvement for the production of fruits and vegetables. During 1930 demonstrations with cover crops were conducted on large areas in North Carolina, Missouri, Arkansas, Kansas, Oklahoma, Oregon, and Washington.

Manure hotbeds are not used so much as formerly because of scarcity of fresh horse manure, so small greenhouses and electric hotbeds are replacing them. Pennsylvania has built more than 700 such greenhouses and hotbeds in the last five years, Connecticut and New Jersey each has nearly as many, and Ohio is well supplied with them. In one house measuring 10 by 18 feet, 20,000 vegetable plants may be grown for spring outdoor planting.

California is again in the lead in cost accounting with 689 records. Of these, 233 were taken in walnut and almond orchards; 256 in apple, apricot, peach, pear, and prune orchards; 186 in citrus orchards; and 14 in vineyards. South Carolina made complete cost accounts on 312 gardens of one-half acre each. Kansas has records of 380 gardens which produced an average net profit of \$97 each. In the sweetpotato work in South Carolina 209 growers obtained yields of from 94 to 339 bushels per acre at a production cost of from \$32.29 to \$88.37 per acre, with a profit per acre ranging from \$14.45 to \$156.49.

PLANT PATHOLOGY

Seed disinfection is an increasingly promising means of disease control. During 1930 the stinking smut of wheat continued to cause serious loss, both in reduced yields and market value, and its control by seed treatment was given continued attention by workers in about 30 wheat States. Seed treatment to control loose smuts of wheat and barley and covered smut and stripe of barley was demonstrated in a number of States. Treating sorghum seed for smut prevention is fast becoming an established practice in Kansas, so further demonstrations along that line are becoming less necessary. An increased number of tests showing profit from treating seed corn has led to that practice being recommended in several Corn Belt States. In Illinois and Delaware average increases in yield of 3 bushels per acre are reported. A tendency toward recommending some newer seed-potato treatments which are more rapid and fully as effective as the older formaldehyde and corrosive-sublimate methods, is noted.

The use of disease-free seed, especially of potatoes, sweetpotatoes, cereals, and various vegetables, was emphasized in all States. The use of resistant varieties is a growing means of disease control. In the case of many crops farmers were assisted in obtaining seed of such varieties.

Spraying is one of the most widely practiced of the various methods of disease prevention. Special spray service for the control of insects and diseases, based on weather conditions, and the development of host and parasite, continued to be given fruit growers in several of the Eastern States. Recent trends in this spray service seem to be (1) use of the radio for broadcasting recommendations, (2) more dependence on accuracy of weather forecasts, (3) extension of spray service to other fruits, such as cherries, peaches, and pears, (4) dependence on county agents or assistant county agents to operate spray service in the counties, and (5) the employment by large companies and groups of growers of their own spray specialists. In spraying potatoes and other field and vegetable crops more emphasis is being placed on the selection and adjustment of sprayers in order to do better work and obtain better results. The interesting fact was brought out in several States that even in a year of drought, when the blight diseases of potatoes were not present, yields were increased to a profitable extent by the application of Bordeaux mixture.

Plant-disease surveys for procuring facts on which to plan extension work and for checking results, continued to be an important activity of extension pathologists and others. Special wheat-smut surveys were conducted in the spring-wheat States and elsewhere. Tobacco-disease surveys in seed beds and fields were made in 19 States and Porto Rico by the Bureau of Plant Industry in cooperation with the States. Not only did these surveys accumulate important data to provide the basis of control work in 1931, but the personal contacts with the growers offered good opportunity for extension work.

The need for reducing the costs of crop production and for raising higher-quality products has resulted in more plant-disease control work being done by county agents and specialists in all States. Experience shows that the comparatively small staff of 26 extension plant pathologists is hardly adequate to meet the demand for technical assistance and that in certain States where there are no such specialists the teaching and research departments of plant pathology and botany are overloaded with extension duties.

FORESTRY

Extension forestry brought results in 1930 in spite of drought and the general depression. The extension foresters in the field have used practical knowledge and the experimental findings of the Federal and State forestry agencies, and have given practical assistance to farm and woodland owners. They received hearty cooperation from the State extension organizations and the active assistance of county agents in establishing woods demonstrations. Farm lands which have been idle or partly unproductive have been put to work to produce their proportionate share of the farm income.

The principal forestry projects during the year were planting, improvement cutting, marketing, fire prevention, and 4-H club work in forestry. Maple-sirup production, protecting the woods from grazing, sawmill improvement, and timber estimating received local attention.

Forest-tree planting continued to be the most popular work, especially in the mid-Western and Plains States where protection from wind is an important problem. New York and Pennsylvania continued to lead all States in the number of trees planted on farms. In a number of States there is a growing interest in tree planting for controlling erosion and for utilizing farm land not needed for crop production.

Improvement cutting and 4-H club work were carried on in 22 States. In a number of States 4-H club projects are designed to give a clear understanding of the elements of forestry. They cover such subjects as tree identification, tree planting, timber estimating, and woodland improvement. Camps, contests, club weeks, pageants, demonstrations, hikes, rallies, tours, and other events were held for boys and girls.

Profitable methods of marketing farm-timber products were emphasized during the year. Lists of timber buyers and bulletins on marketing were distributed. Illinois, Ohio, North Carolina, Tennessee, and New Hampshire gave practical timber-marketing assistance.

In California, Arkansas, and Mississippi, fire protection was demonstrated, and large groups of farmers took adequate measures to protect their woods from fires.

More effective methods to reach farm owners were used during the year. In Michigan a forestry train of three cars stimulated greater interest in the planting of trees. More than 25,000 people were reached. Among Ohio farmers notable progress was made in improving woodlands and protecting sugar maples from live-stock. New Jersey obtained group action through the junior 4-H club educational work. Iowa junior forestry teams at demonstrations and fairs aroused a state-wide interest in planting windbreaks. Nebraska, New York, Pennsylvania, and Arkansas used campaigns with marked success. Field demonstrations, tours, camps, visits to State forests, parks, and experiment stations, circular letters, contests, news stories, exhibits, news-letters, lectures, and radio talks aroused much interest.

The State forestry departments supplied, at a nominal price, most of the planting stock used by farmers during the year. Extension foresters received helpful cooperation from State forestry departments, State colleges of agriculture, experiment stations, farm bureau federations, county and community agricultural organizations, State departments of agriculture, education, and conservation, nurserymen, women's clubs, lumbermen, railroads, and the press.

Thirty-two States and two territories cooperated with the United States Department of Agriculture under section 5 of the Clarke-McNary law of June, 1924, and the Smith-Lever Act of May, 1914, in forestry extension. Pennsylvania and New York had two extension foresters each, making a total of 36 subject-matter specialists in forestry.

ANIMAL HUSBANDRY

On an animal-unit basis, there was little change in the total number of livestock in the country in 1930 as compared with the total for the previous year. Increases in the number of cattle and sheep were offset by decreases in horses, mules, and hogs. However, the inventory value of the nation's livestock on January 1, 1931, as estimated by the Bureau of Agricultural Economics, had declined more than a billion and a half dollars, or more than 25 per cent, as compared with the value on the same date in 1930.

The influences responsible for such severe losses in the livestock business naturally affected animal-husbandry extension work to a considerable degree. The worst drought in a generation took its toll in decreasing feed supplies, including pasture. The surplus of wheat which lowered wheat prices and put that grain on a feeding basis, presented other new problems. Widespread bank failures emphasized the need for better methods of financing the livestock industry. The general business depression made it necessary to apply all known means of lowering production costs, in attempts to meet lower price returns. Live-at-home programs came into popularity almost everywhere. All cooperative efforts were stimulated by the economic situation.

Except for the large volume of emergency work which demanded attention during the year there was little deviation from the long-time program of work which has been in effect in most of the States for some time. Most of this work had to do with complete cycles of production and included all practices essential to successful livestock farming. This type of activity requires the cooperation of workers in other subject-matter lines and tends to unify efforts because it embraces a more or less complete system of farming. The pork-production clubs, an outgrowth of the ton-litter work, are an example of this type of activity.

The member of the newer type of pork-production club applies all the principles of improved swine production to all the brood sows, and their offspring, on his farm. In 1930 the demonstrators in one State produced 99 litters of pigs, which litters averaged more than a ton in weight at the age of 6 months. Demonstrators in the single-litter project, in which attention was concentrated on one litter of pigs, seldom produced more than 75 ton litters in any State in one year.

Demonstrations of both methods and results continued to be the backbone of efforts to extend the adoption of recommended practices. Meetings, tours, circular letters, news articles, and other means of publicity were used to increase interest.

Leadership personnel remained about the same as during recent years, except in the South. There several additional specialists were employed through funds made available by a special appropriation to the Bureau of Animal Industry for beef-cattle and related livestock work in areas recently released from cattle-tick quarantine.

DAIRY HUSBANDRY

The depression and the carry-over of dairy products made the dairy-extension work rather difficult during 1930. It was necessary

to reduce the cost of producing milk, not necessarily to meet competition but to help sustain consumption of dairy products.

Dairy-herd improvement as a long-time project has been given general attention. This work includes testing dairy cows, introducing better bulls, and keeping records to determine the best milk-producing strains and to furnish definite data which will enable dairymen to keep production costs at a minimum. In California 12.9 per cent of the dairy cows are under test. This State ranks highest in this respect. A considerable number of States hold State or regional conferences for testers. Farm-management and crop specialists and veterinarians, in addition to the dairy specialists, participate in these conferences.

Dairy-cattle breeding as a long-time project has been based largely on dairy-herd improvement records. The breeding work is handled in different ways in different States. In some States a state-wide campaign for the use of purebred sires is used. First, a survey of the sire situation in each county is made. This is followed by a campaign urging owners to replace scrubs with purebred dairy sires. Better-sire trains have been operated in a few States. Purebred-sire contests were held, cooperative bull associations organized, and dairy-cattle breeding schools held to interest dairymen in owning purebred sires.

Dairy-cattle feeding has received much attention, particularly in those States affected by drought. Feeding problems have generally been studied in conference with State specialists. In States where there was a shortage of feed, general information was given through circular letters, newspapers, and other avenues that would reach as many people as possible. In some of the Eastern States a specialized monthly feeding service has been developed. In States where the supply of feed was not a serious problem, farmers were taught to balance the individual cow's ration accurately. This instruction reached only a limited number of dairymen.

Milk-quality improvement work has been conducted in different ways. A sentiment demanding a good quality of milk had to be developed first. Two features have stood out—the relation of quality to demand and price, and its relation to health. The dairyman has quality control practically in his own hands. The dairy specialists have cooperated with creameries, milk-distributing plants, State boards of health, and with the dairymen themselves in determining what problems are to be attacked. This work has been particularly suitable as a 4-H club project. Outlines and programs for it have been prepared in several States.

POULTRY HUSBANDRY

Poultry-extension work covered both production and marketing problems in 1930. The decrease in the price of eggs and the unfavorable ratio of egg prices to poultry-feed prices caused many changes in poultry work. The reduced profits first halted the rapid expansion of the poultry industry.

Modern mechanical developments have done much to increase the number of poultry. Incubators that are practically automatic in their operation hatch a larger percentage of chicks than the old

sitting hen. Large brooders with temperatures controlled by thermostats enable the operators to keep big lots of chicks in a single unit. The newer knowledge of nutrition makes possible a more nearly balanced diet. These factors have had a tendency to put poultry raising on a factory or mass-production basis. The farm flock is still the most important source of poultry products, and in general the poultry-extension programs have aimed at improving the efficiency of these flocks. This has been done through a large variety of means and agencies. Meetings and schools have been held, tours organized, and bulletins, circular letters, and press notices prepared.

With a general decrease in prices of both feeds and poultry products, more attention is being paid to economical feeding. Several States have reported that increased numbers of farmers were grinding and utilizing home-produced grains in order to reduce the cost of feed. Remodeling old buildings has to a certain extent replaced the construction of new poultry houses. Three Southern States issued plans for a simple homemade brick brooder.

The extension workers organized 4-H poultry clubs and furnished them with a large amount of specially prepared literature. An added stimulus was given to this work by training demonstration and judging teams. Interstate contests in poultry judging and production are held in St. Louis, Chicago, New York, and Memphis.

One of the most extensive projects in poultry-extension work is based on the demonstration farm flocks owned by farmers who agree to follow recommended practices. Monthly reports are issued and include timely suggestions on improved practices and many valuable economic data. Centering around these demonstration farms is a campaign popularly called "Growing Healthy Chicks."

Poultry-extension work in 1930 was aided by six new motion-picture films prepared for the World's Poultry Congress exhibit and now released for distribution in the United States.

Extension work in poultry husbandry is carried on in all of the 48 States and in the Territory of Hawaii by the United States Department of Agriculture and the State agricultural colleges through the agricultural extension service. In 1930 1,589 county agricultural agents conducted 51,665 poultry demonstrations with adults. Directing the county workers in their poultry activities were 76 full-time poultry specialists and 5 persons who spent part of their time on this subject.

ANIMAL-PARASITE AND DISEASE CONTROL

Animal-parasite control is a new activity established by the office of cooperative extension work through the cooperation of the zoological division of the Bureau of Animal Industry. E. M. Nighbert was assigned to this work, and took up his duties November 1, 1930.

Parasites take their toll in work, meat, milk, wool, and eggs, and by interfering with health, normal growth, and development. They often cause the death of animals. As a rule, parasitized animals do not show fever or outstanding violent symptoms of disease, therefore their suffering may go unnoticed for long periods. There are no exact figures showing the actual loss from parasites, but observations and investigations indicate that their toll runs into many millions of dollars annually.

Extension veterinarians in 15 States are serving as subject-matter specialists in control of animal parasites and diseases of farm livestock and poultry. They deal principally with parasitic diseases and such infectious diseases as infectious abortion (Bang's disease) of cattle. Infectious abortion is controlled by measures requiring blood testing and isolation, sanitation, or slaughter. Parasitic diseases, such as roundworm infection in pigs, are controlled through a system of swine sanitation which requires that pigs be farrowed in clean pens or fields to avoid exposure to disease and worm-contaminated hog lots. Sanitary precautions are sometimes supplemented by medication.

The methods employed in teaching animal-parasite and disease control are educational meetings for farmers and stockmen, visual instruction, demonstrations, and organized efforts through the leadership of the State extension service, practicing veterinarians, State livestock sanitary officials, farmers, and others interested. Bulletins, leaflets, posters, press reports, exhibits, demonstration farm schools, and radio addresses are used.

A nation-wide parasite and disease control program is being organized and promoted.

ENTOMOLOGY

Specialists in entomology developed programs in 1930 that emphasized the importance of preventing insect damage rather than attempting control after damage had occurred.

Orchardists were given information as to the proper time to apply spray materials in order to produce fruit free of insect attack. In New York this service was also made available to truck growers who experienced trouble with insects.

The control of cutworms, grasshoppers, Hessian flies, cotton-boll weevil, and other insects attacking field crops was emphasized by the entomologists of the North Central, Western, and Southern States. In Nebraska large acreages were treated for the control of cutworms.

Specialists in Kansas and Iowa devoted time to the control of insects attacking livestock. In Iowa the control of horse bots, particularly the red-tailed bot, was handled through organized campaigns. In Kansas local leaders furthered insect-control work.

Apicultural extension activities included demonstration apiaries, disease control, study of the value of bees for pollinating orchards, and the organizing of beekeepers.

Extension specialists in entomology conducted, on the average, 156 meetings each. The average attendance at these meetings was 101. Direct contact was made with an average of 15,977 persons by each entomology specialist. The entomological extension programs dealt with the control of about 110 different species of insects.

Entomological extension work was conducted in 30 States with all or part of the time of 54 staff members devoted to it. Entomology specialists handled insect control and in some States apicultural and rodent control. Thirty-three full-time specialists were paid from extension funds in 19 States; 11 part-time specialists were paid from extension funds in 8 States. In addition, 10 specialists were paid from funds other than those of the extension services of the 8 States in which they worked.

AGRICULTURAL ENGINEERING

The tendency to improve farm-labor efficiency by using larger power units per worker and by advancement in farm implement and machinery design, continued to be a dominant factor in the agricultural situation, even with no shortage of farm laborers. The low prices of important agricultural commodities due to world surpluses make it necessary to use farm labor efficiently in order that a margin of profit between cost of production and marketable value may be retained. Labor efficiency is often the determining factor in profitable production under severe competitive situations. During the year adult result demonstrations in land improvement, machinery, and building projects were conducted. Interest in 4-H club engineering projects increased. The junior projects included terracing, field machinery, gas engines, and shop work.

Promotion of hillside-drainage practices to prevent soil erosion is the major agricultural-engineering extension activity and is increasing in its importance and spread of influence. Terraces and soil-saving dams to prevent erosion were constructed at costs ranging from \$2.50 to \$10 per acre. Terracing is usually done at seasons when labor and power are not needed in production operations. Frequently increased crop yields pay the cost of terracing. Other land-improvement operations on lands already in cultivation include clearing stumps and stones and installing drainage and irrigation systems. Drought stimulated interest in irrigation for truck gardening in the Eastern States.

Farm-home life was improved by extension agricultural engineers who furnished plans for new dwellings and for remodeling houses, and gave information and recommendations resulting in the installation of lighting systems, water systems, sewage-disposal systems, and heating systems. Buildings for housing livestock, storing and handling farm products, and for other purposes were constructed or remodeled in accordance with plans furnished by extension agricultural engineers.

The increasing availability of electricity for farm utilities and conveniences, resulting from the rapid extension of power lines, has placed upon the extension service a new responsibility for acquainting farm users with the safe, profitable, and convenient use of electricity according to practices approved by experiment stations and other authoritative agencies.

FOODS AND NUTRITION

Organized projects in child feeding were more numerous in 1930 than theretofore. Since the children of many members of established home demonstration groups have grown up and left the farms, most States now combine the child-nutrition project with work on food selection and preparation, or on feeding the family or similar units. The general principles of these projects are definitely applied to the food needs of children, and attention is directed to the child-nutrition problems of the communities.

Interest thus aroused makes it feasible to carry on a child-feeding project as a second or third year project in the nutrition program, prefacing it with a special effort to interest young mothers who were not members of the original home demonstration group.

In some States specialists and agents visited typical homes in order to discuss, at first hand, the problems and needs of mothers of young children. In other States child feeding has been made a part of a composite project for such mothers, the project including clothing, furnishing, home management, and child training. Subject matter for such projects is worked out in conference among the specialists concerned.

Several States have sent out circular letters carrying advice on child feeding, care, and training. Such letters have gone directly to mailing lists of interested mothers. A few States used such letters as the only child-feeding project, while others used them to supplement project meetings or to extend the influence of the project. Home demonstration groups frequently sponsored preschool clinics, improved the lunches which school children carried from their homes, or promoted the serving of hot lunches at school.

There was a marked tendency in 1930 toward coordinating certain phases of the nutrition project with work in household management and in child training. Short projects on community meals reviewed food selection and preparation principles developed in earlier projects. Community meal contests, originally developed in certain Eastern States, were carried on by a number of States last year, and proved an effective means of bringing nutrition teaching before men as well as women.

Extension nutritionists assisted in standardizing recipes for various types of cooked food to be sold on home demonstration markets. A subcommittee of the extension nutrition committee undertook to summarize the contributions of State nutritionists and presented its report at the annual meeting of the American Home Economics Association in 1931.

Illinois, New York, Iowa, New Jersey, and Massachusetts, all having large, prosperous farms or extensive suburban areas, have pioneered in the field of food buying. Because of the protracted agricultural and industrial depression, intensified in some sections by drought, a majority of States modified existing food-selection projects or developed special projects to plan adequate low-cost diets. Guided by department and State extension nutritionists, agents in the South advised with planters, food merchants, and Red Cross committees on low-cost pellagra-preventive diets. Such discussions emphasized the economic as well as the health value of the live-at-home program. Many agents in other sections helped local relief agencies to plan low-cost adequate diets at local prices. More States reported joint garden and nutrition projects based on the food-selection and seasonal planting plans, for providing vegetables sufficient in variety and amount for canning, storing, and use when fresh. Food-preservation budgets adjusted to climatic conditions guided home makers in putting up enough of the right kind of fruits and vegetables to meet nutritional needs during nonproducing months.

The prospect of actual food shortage in the drought-stricken regions of 26 States inspired a feverish interest in growing fall and winter gardens, many of them from seed collections recommended by State gardening specialists and donated by the Red Cross. Gardening, the use and canning of vegetables, and the canning of poultry and meat animals to save feed, engrossed the attention of many home

demonstration agents in the drought-stricken States during the late summer and fall. In some counties additional canning equipment, to be used under the direction of the agents or of experienced club members, was made available by the Red Cross, by bankers, or other agencies.

Food projects for 4-H club girls, organized around the nutritional needs of the girl and her family, the girl's own health, the preparation of well-selected meals, the food-preservation budget, and simple entertaining, were outlined. Membership in 4-H food projects increased. Further progress was made in growth work, which received recognition in the resolutions adopted by club leaders at the National 4-H Club Camp in June, and was emphasized at State and county camps and short courses during the summer.

Extension nutritionists of the eastern region met in conference in February.

The information on food and nutrition projects, issued during the year, was improved in quality and volume. Feature articles, news stories, radio talks, local, county, and State exhibits, achievement days, campaigns, picnics, and tours were used. Local leadership was somewhat further extended. Health officers, relief agencies, parent-teacher associations, merchants, bankers, and others have cooperated liberally in the work.

A 2-reel motion picture for 4-H clubs, Good Posture Wins, was prepared in cooperation with Virginia extension workers. Special reports on extension activities in the child-development project and in the foods and nutrition project were prepared for the White House Conference on Child Health and Protection. As a member of the subcommittee on nutrition of the National Drought Relief Committee, the extension nutritionist collaborated with representatives of the Bureau of Home Economics, the United States Public Health Service, and the American Red Cross in preparing a mimeographed extension circular entitled "Buy Health Protection with Your Food Money," later revised for printing as Miscellaneous Publication 113, Adequate Diets for Families with Limited Incomes, a pellagra poster, and a small 4-page illustrated leaflet, Protect Yourself from Pellagra, of which last half a million copies were printed.

• HOME MANAGEMENT

Home-management specialists developed programs on kitchen improvement, household economics, time management, the managerial responsibilities of the home maker, and the wise choice and use of electricity and other labor-saving equipment.

The long-time aims presented by extension workers have economic, physical, and social aspects. Spending the family income wisely and to the greater satisfaction of the family, discriminating between luxuries and necessities in purchasing, making the farm produce more of the home living, following better methods in doing household tasks, and studying the value of the housekeeper's time are economic problems. Remedying the lack of standards in farm-home building and meeting the need of water systems, better lighting facilities, and sanitary measures are the physical aim. The social problems require study of ideals in home making, an analysis of the

home maker's traits, and recognition of the obligations of the home maker to the community as well as to her family.

The home-management project is being developed in cooperation with the specialists in agricultural engineering, nutrition, farm management, clothing, landscaping, and child care and training. The procedure in developing the cooperative projects is much the same regardless of the subject matter involved. When work on water systems is to be undertaken, the agricultural engineers and home-management specialists confer and develop a plan of work. The home demonstration workers usually arouse interest in the project through kitchen-improvement work. The agricultural engineer then follows, giving technical information, and assisting interested cooperators with the details of installation, while the home management specialist assists the home maker in deciding where the water-system equipment is to be placed in the house. Both specialists and agents, through personal visits and other means, urge the completion of the project and give publicity to the demonstration through newspapers, circular letters, and tours.

In developing a cooperative project on "Buymanship," or household accounts, the home-management specialist and home demonstration agent start the work by giving the women a general background of the economic situation as it affects the home, and enroll the home makers in household account keeping. The food specialist then meets with the women and discusses wise food selection and the value of the home garden; the clothing specialist next adds her contribution in the form of information on clothing costs. Other specialists discuss the economic phases of their projects. The home-management specialist finishes the work with an analysis of the accounts kept during the year.

The home-management extension staff in 1930 included 42 full-time members employed in 39 States.

HOME FURNISHING

The objective of the home-furnishing work is to create a pleasing background in the home so that it may be conducive to the best physical and mental development of the family.

The human tendency to endure things as they are rather than to put forth the effort to change them, poor judgment in selecting furnishings, a lack of knowledge of fabrics and woods, a limited amount of money, and poor shopping facilities, are problems met by the home-furnishing specialists in their work with rural women and girls. (Fig. 14.)

The demonstration home continues to be the basis of good home-furnishing work. After a home maker indicates her desire to make improvements in her home, a meeting for the community women is held, at which the principles of house furnishing are discussed as they relate to particular problems in this home. Wall finishes, color, floor coverings, slip covers, and accessories may be discussed at later meetings. The home demonstrator carries out as nearly as possible the changes decided upon, and at a follow-up meeting or tour the neighbors and friends have an opportunity to see the improvements made. All of the improvements contemplated can not always be

accomplished in a year, so the home maker continues her cooperation with the extension specialists and agents over a series of years. Extension agents' reports speak often of such long-time demonstration houses and their value to the communities.

During 1930 the interest in problems relating to the wise choice of house-furnishing materials was so keen that extension staffs arranged tours to stores to study the buying of rugs, draperies, curtains, or other furnishings. Mention of

"consumer purchasing" and "merchandising studies" appear frequently in the 1930 reports, and extension specialists have prepared many leaflets to answer questions on these topics propounded by home makers.

Every State has done some work on making the interior of the rural home more attractive and livable, though only 14 full-time house-furnishing specialists were employed in nine States during 1930. The work in other States is being developed by home demonstration agents, State leaders, or home-improvement or home-management specialists.



FIGURE 14.—An improved clothes closet in a 4-H club girl's bedroom

EXTENSION IN AGRICULTURAL ECONOMICS

Phases of extension work in agricultural economics receiving most attention and emphasis in 1930 were agricultural outlook and adjustments, farm organization and management, marketing principles and efficiency, land utilization, taxation, insurance, community organization, owner-tenant adjustments, and farm credit.

AGRICULTURAL OUTLOOK AND ADJUSTMENTS

Extension work dealing with agricultural outlook and adjustments had a healthy growth during the year, and the demands made for this type of information far outstripped the ability of the department to supply it. Both the State forces in economics and the individual farmers are making increased demands for accurate and

timely economic data. Outlook work is not considered a separate and distinct part of the extension program. It is closely coordinated not only with other economic work but with the entire extension program. The fact that outlook work was more than doubled during the year was due in large part to the greater stress placed on adapting and applying outlook information locally.

In addition to the National Outlook Conference five regional conferences were held during the year. The national conference enabled State workers to make contact with the many sources of information in the Bureau of Agricultural Economics, and with all other State workers. It is also the only means by which State workers can follow interregional adjustments. The regional conferences are a logical step in the development of a year-round extension program for disseminating economic information. They afford a means of making outlook information on certain commodities available in the different regions at the time when it is most valuable. They also afford a much-needed opportunity for further localizing outlook information and concentrating time and effort on commodities of major importance in the area. Through State committees and other means much information was carefully assembled and interpreted and brought to the regional conferences to supplement the national data. Plans were also more carefully organized for getting material to the county agents and helping them to train leaders to give it wide projection and application. Carrying out this plan brought about the best possible teamwork, through group effort, of State and Federal workers.

FARM MANAGEMENT

One of the outstanding activities of economic workers during the year was the development of present-day extension programs in terms of the farmer's business as a whole. Trends in the relation of production and marketing demands were studied and recommendations made for applying these trends to practices and systems of farming.

The application of good farm-management principles was taught, and stress was placed on the facts that provide an understanding of the types of farming areas and what constitutes good farm and enterprise organization and practice. The development of a satisfactory farm-accounting service was also emphasized in this program.

Much assistance was given in building good economics-extension programs. Through teaching the factors that make for success, there has been developed a marked appreciation of the value of a proper economic background when considering trends in the supply of products and in price variations. In cooperation with home-management specialists, facts on farm management, cost of living, and related matters have been so interpreted as to be of the greatest value to farm and home managers.

The farm-account project, one of the fundamental activities of all economics extension workers, is a major item in most States. Some of the means used to further this project were letters sent to carefully selected lists of farmers asking them to undertake the work, talks at farmers' meetings emphasizing its importance, schools for training in account keeping, help offered in farm-business analysis

at the end of the year, and showing the farmer how account keeping will help his business.

The special farm-account service project now under way in a number of counties in Illinois, Iowa, Kansas, and Minnesota, where farmers pay for an intensive farm-management service, is the result of demands from farmers for more assistance after cooperation with the county agent in the regular accounts project. Besides the general farm accounts, enterprise-efficiency accounts have received much attention in some States.

To facilitate better account keeping many States conduct accounting schools where details of inventory, receipts, expense-keeping, and farm business analysis are taught. In some States the rural schools are offering courses in simple farm accounting to seventh and eighth grade pupils.

The summary and analysis of accounts may be made at the State college or in the county agent's office and followed by visits to the farmer to discuss briefly with him the final summary of his preceding year's business. Sometimes the summary is mailed to the farmer, or he may visit the county agent's office to obtain it. Another very effective educational method is to hold schools in which groups of farmers are assisted in making their own summaries and analyses.

A great deal of work with young people has been done by extension specialists. Various 4-H club programs include training in the business principles that underlie farm activities.

MARKETING

During the year 1,685 cooperative-marketing associations were organized as compared to 1,089 the previous year. Assistance was given to 7,539 other associations, or about three times the number for the previous year. The membership of these associations was 857,148; the value of products marketed through them was nearly \$300,000,000; and the value of supplies purchased through them was about \$43,000,000. The problem of keeping members informed was the first to be given attention, and 3,410 associations were reported as being aided in its solution. The use of current information was second, organization third, business policies fourth, production to meet market demand was fifth, and standardization sixth. Help was also reported as being given on other problems: 38,808 farmers not in cooperative associations were assisted in standardization, 31,983 were assisted in packing and grading, and 95,983 were assisted in the use of current market information.

In many regions economic specialists have been successful in preventing the formation of unnecessary cooperative associations. Assistance in merging into larger units was given to 1,005 associations or groups. Special studies have also been made upon marketing opportunities and procedures, as well as upon collateral subjects such as credit situations, the extension of credit by car-door agencies, and the general outlook for financing marketing activities.

The interstate early-potato committee program, formulated as a continuous plan of action for reaching some effective solution of the potato-marketing problem, has been expanded to include Florida, Georgia, and South Carolina. The other States included are Maryland, Virginia, and North Carolina.

Because no one area could change the situation by itself the work of this committee has given particular emphasis to interstate cooperation and coordinating the efforts of all agencies interested in potato problems. Four subcommittees dealt with particular problems during the year. These problems concerned acreage and advance information, credit, substitute crops and enterprises, and marketing. Continuous contacts with the various interests associated with the potato industry were made possible by a complete mailing list of persons and organizations interested in the potato industry. This list includes growers, bankers, newspapers, fertilizer interests, cooperatives, supply merchants, and public workers. Special information is sent to these interested classes when it is available or necessary. In every area meetings were held at seasonal periods for discussions of production and marketing information, and practically all interests were represented at these meetings. This work is bringing about closer cooperation between the growers, marketing agencies, supply merchants, and others interested in a more profitable potato industry.

Since the establishment of the interstate early-potato committee other producing areas have shown interest in a similar movement. After careful consideration the agricultural interests in Washington, Idaho, and Montana established a Pacific Northwest potato committee in September, 1930.

ECONOMIC PROGRAM MAKING

Economic facts as a general background for the whole extension program were more extensively used in 1930 than in any previous year. The activities of the Federal Farm Board, the crisis in the price of many agricultural products, and the drought focused the attention of every one interested in welfare of rural people upon the economic problems of these people.

During recent years specialists in poultry, dairy, crops, and livestock have been asked to assist in formulating the State outlook reports for the enterprises in which they are interested. In 1930 an increased number not only gave this assistance but went into the field and presented the outlook data in regions where their enterprises were the principal sources of income. This procedure required that the economics and subject-matter specialists jointly consider efficient methods of production and decide what enterprise readjustments would bring the farmer the most profit. To this end both specialists required a thorough understanding of farming systems.

In many States the subject-matter and economics specialists conduct joint extension projects dealing with efficient management of enterprises. The methods and practices found to be more profitable become the subject-matter specialists' extension program for the enterprises involved. This plan of cooperation has also been extended to the county workers. These county workers are informed on subject matter and supplied with charts, leaflets, and outlines, so that they can present the economic data. In these programs the State leaders for county extension work and the directors of extension, as well as subject-matter specialists, have taken part.

Not only do extension workers concern themselves with efficient methods and more profitable systems of farming but they determine what volume and efficiency are necessary to provide the living that

farmers want for themselves and their children. The home-economics extension workers have studied the kind of living farm people want and its probable costs. As a result, their programs are being revised to meet more nearly the resources of the farm people. The young farm people also are getting a much clearer idea of the kind of living they can obtain from farming and of their opportunities for obtaining an equal or better living in some other occupation.

ECONOMIC EXTENSION PROCEDURE

Many ways and means were used to widely project and apply economic information. Improvement was made in preparing material for extension uses, in presenting it, and in coordinating all known methods of effective teaching. The following outline gives an idea of the procedure generally in use:

Outlook work (State and local)—(1) Preparation and distribution of outlook information; (2) county program-building committee work; (3) meetings and conferences; and (4) stimulation of cooperative associations and other farm organizations to keep members informed.

Farm management.—(1) Farm-management extension schools and meetings; (2) conferences for making farm plans and budgets; (3) enterprise-efficiency analysis; (4) farm-account keeping and analysis; (5) farm-management tours; (6) young farmers' and 4-H farm-management clubs; (7) community farm-management surveys and programs; (8) inventory and credit-statement campaigns; and (9) banker-farmer-merchant conferences.

Marketing.—(1) Marketing trips and tours; (2) marketing extension schools and meetings; (3) marketing surveys and program building; (4) grading and packing demonstrations; (5) business analysis and counsel for marketing agencies; (6) business management and accounting schools and conferences for managers and directors; (7) current marketing information; (8) improvement of marketing facilities; and (9) stimulation of farmers' organizations to keep members informed of economic conditions and results of research.

General.—(1) Owner-tenant adjustments (lease reforms); (2) land-utilization conferences and programs; (3) insurance; (4) taxation; and (5) correspondence courses.

In addition, assistance in connection with the foregoing activities, was given through informational mediums such as radio talks, press articles, extension bulletins and circulars, and monthly economic publications.

EXTENSION STUDIES AND TEACHING

STUDIES UNDERTAKEN

Research in extension methods continued to receive major emphasis on the part of the office of cooperative extension work and cooperating State extension divisions in 1930. In addition to analyzing, summarizing, and preparing reports based on the studies undertaken in South Carolina, Kentucky, and New Jersey during the previous year, other studies were initiated in Kansas and Missouri. In Kansas data were obtained on the progress made by the wheat program intensively carried on by the extension service for five years. At the same time data were also collected on two home-economics projects—clothing, and health and sanitation. In Missouri similar data were collected on the legume program as conducted in somewhat different ways in eastern Missouri counties. A total of 1,180 farm and home records were obtained, making a grand total of 17,121

farm, home, and leadership records collected by this unit of the office in cooperation with the State extension services during the eight years such studies have been conducted.

Further studies of the educational values in 4-H club work were made during the year. An analysis of the circular letters used by extension workers was made, and some light thrown upon the problem of reaching more of the farm women who do not affiliate with the formal home demonstration clubs.

With the assistance of W. W. Clark, assistant county agent leader in Wisconsin, whose services were lent to the office for the purpose, marked progress was made in studying the functions and activities of that large group of extension workers charged with responsibility for supervising the county extension agents and their work. When completed, the report of this study is expected to be a valuable contribution to extension literature.

CIRCULAR LETTERS

In analyzing the use of circular letters by extension agents, particular attention was given to the authority mentioned for the subject matter contained in the 2,353 letters studied. Approximately 44 per cent of the letters carried subject-matter information. The opinions of agents and specialists furnished the basis for at least part of the subject-matter information contained in 92 per cent of the letters. The successful experience of a farmer or farm woman in the community was narrated in 6 per cent of the letters, and in 3 per cent a result demonstration was cited. Work of the experiment station and the United States Department of Agriculture, the method demonstration, and agencies outside of the extension service were each mentioned as authorities in less than 1 per cent of the letters.

REASONS FOR NOT JOINING A HOME DEMONSTRATION CLUB

Recent studies of home demonstration work in Kentucky, New Jersey, and South Carolina provided information on the possibility of enrolling in clubs or otherwise influencing the 447 farm women in the areas studied who had never been affiliated with a home demonstration group. That they had no way to get to club meetings was the outstanding reason given by women in all three areas for not joining a home demonstration group, 36 per cent of the women mentioning this reason. Lack of interest in the home demonstration club program kept 20 per cent from joining. Fourteen per cent of the women reported that they had no one to care for their small children during their absence from home. Thirteen per cent reported lack of time to attend meetings. Their own poor health or that of other members of the family was the reason given by 10 per cent of the women. Six per cent stated that no club had been organized within reasonable distance. Two per cent, each, reported advanced age, objection to attendance at club meetings on the part of members of the family, and unsatisfactory meeting places, as reasons for not having joined a home demonstration club.

EDUCATIONAL VALUES IN 4-H CLUB WORK

This study was handled in three parts, one dealing with opinions of county extension workers, one relating to club members, and one dealing with opinions of parents of club members. Of special interest are the statements of boys and girls on how they have been helped by club work. Self-reliance, knowledge of up-to-date farm and home practices, higher appreciation of farming as a life occupation, and participation in community affairs are some of the more important ways in which club members think they have been benefited by club work.

VALUE OF AN IMPROVED PRACTICE

For the first time in an extension field study, information on the economic value of adopting improved practices was obtained. The farmers studied who adopted no extension practices obtained an average yield of 9.40 bushels of wheat per acre, whereas the group of farmers who did adopt improved wheat practices obtained an average yield of 11.84 bushels per acre. The rate of increase in yield per acre, 2.44 bushels, applied to the 370 acres of wheat grown per farm in the practice group, gives a total increase of 903 bushels of wheat per farm due to extension influence.

TRAINING COURSES FOR EXTENSION WORKERS

Beginning in 1929 the Federal Extension Service, through the division of extension studies and teaching, has cooperated with the University of Wisconsin in developing professional training courses on the graduate level for extension workers already in the service. Much of the material for such courses is drawn from the various studies of the office of cooperative extension work. During the summer of 1930 two courses in extension methods were given by the head of the division. One of these was a repetition of the course given in 1929. The other was an advanced course designed primarily for those who had taken the 1929 course.

A total of 37 students were enrolled in the 1930 extension courses, 31 of whom were experienced extension workers. These students represented 12 States and 1 foreign country: Maryland, Massachusetts, Vermont, and Pennsylvania in the East; Arkansas, Georgia, and Oklahoma in the South; Montana and Oregon in the West; and South Dakota, Wisconsin, and Missouri in the Central States. South Africa was represented by two graduate students from the Union Department of Agriculture.

COURSES FOR NEGRO EXTENSION WORKERS

During the summer of 1930 three special schools for negro extension agents were held. The schools were located at the agricultural colleges for negroes at Orangeburg, S. C., Nashville, Tenn., and Prairie View, Tex., from August 4 to 30. They were made possible through the financial aid of the Julius Rosenwald Fund, of Chicago, which appropriated \$20,000 to help finance them. These funds were used to pay the salaries of teachers and to purchase the necessary equipment for teaching. The plan of organizing and conducting the

schools was a cooperative arrangement among the Federal and State extension services, the white and negro land-grant institutions of the South, and the Julius Rosenwald Fund. These schools were under the general supervision of J. A. Evans, associate chief of the office of cooperative extension work. E. H. Shinn, as active director, gave considerable time to organizing and directing the schools, and prepared the report on them which was published by the Rosenwald Fund.

About 300 of the 325 negro extension agents of the Southern States attended these schools. The teaching staff was composed of both white and negro teachers and extension workers. The courses offered included poultry husbandry, dairying, agricultural economics, agricultural engineering, extension methods, home management, and foods and nutrition.

INFORMATION AND VISUAL INSTRUCTION

Extension publications continued in 1930 to be an invaluable aid to county extension agents in extending information and in supplementing subject matter disseminated in connection with meetings, office and farm visits, and correspondence. A trend toward brevity, appropriate illustration, and more attractive make-up in the preparation of new publications was noted. County extension agents reported distribution of 6,657,561 publications during the year. The publication output of State extension divisions in 1930 included 2,016 printed documents, consisting of 265 bulletins, 445 circulars, and 1,306 miscellaneous publications. The office of cooperative extension work prepared for publication the annual report on cooperative extension work for the year 1928 and two department circulars presenting extension activities and teaching methods of interest to extension agents.

In May, 1930, the department Extension Service issued the first number of a printed house organ entitled, "Extension Service Review." Throughout the year, the Review has carried stories of extension accomplishment, results, and methods designed to furnish definite assistance to extension workers in conducting their work. It was evident by the end of the year that the periodical was aiding materially in the exchange of ideas and the coordination of effort in the extension field. The Review is distributed without charge to all cooperative extension employees, and has a subscription rate of 50 cents a year for others.

The office of cooperative extension work contributed 26 mimeographed circulars to the Extension Service series of circulars during 1930 and issued 348 mimeographed miscellaneous publications dealing with various matters of interest to extension workers.

NEWS SERVICE

County extension agents reported preparing 449,854 news stories in 1930. There was a noticeable improvement in the quality of the news stories and their adaptability to press use. Instruction in news writing received by agents in 1930 and in previous years was bearing fruit. The most effective instruction of this character reported was that given by the extension editors in extension conferences of agents

and in direct personal visits to the counties. Agents who had received instruction in elementary news writing in college almost invariably produced high-quality news stories.

No record of the total number of news articles prepared by State extension divisions was kept, although in most States, a considerable output of news stories by the extension editor were released to local dailies and weeklies and syndicated to press associations. In making extension information available nationally, the office of cooperative extension work cooperated with the department press service in assembling and preparing 150 articles for the Official Record and for press release. There were also 1,200 news photographs released and material was collected and made available to 77 representatives of farm papers and magazines, and syndicate and free-lance writers.

VISUAL INSTRUCTION

Staging and taking photographs for subject-matter lantern-slide and film-strip series was continued by the office of cooperative extension work in cooperation with State extension divisions in Florida, Maine, Maryland, Massachusetts, Michigan, New York, and North Carolina. Instruction in staging and taking photographs and in organizing visual material for teaching purposes was given at State and district conferences.

In Michigan a new type of instruction was attempted. The field photographer of the office of cooperative extension work was sent into the field with the photographer of the State extension division to assist in staging photographs to illustrate extension results and activities. Two trips to Michigan were made by the department photographer, one early in the spring and one in the late summer. Between these visits the photographer of the State extension division continued taking the series begun on the first trip, and on the return of the department photographer the results of the work were studied and the series was completed.

In Maryland, intensive instruction was given to extension agents in Harford and Frederick Counties with a view to having them take a number of series of photographs. Six agents participated in this work. Two were county agricultural agents, two were home demonstration agents, one was an assistant agricultural agent, and one an assistant home demonstration agent. Series were completed on the following subjects: Economical feeding of dairy cows, Modern dairy equipment, Dairy calf-club work, More tomatoes on fewer acres, Grow healthy poults, Some flower gardens in Maryland, and Boys' and girls' 4-H club camp. Several of these series were immediately organized into local film strips for display and discussion at the annual conference of county extension agents.

Film-strip reproduction in lantern-slide subjects on films showed a marked increase in use by county extension agents. During 1930, 5,892 film strips were purchased by extension workers in comparison with 3,279 strips purchased the previous year. A considerable number of extension division leaders and county extension agents also took advantage of the department's contract with a commercial firm for the making of film-strip negatives and prints for local use.

Extension agents continued to use motion pictures despite the fact that the "talkies" have so rapidly superseded the silent pictures in

the commercial field. There were 1,429 shipments of department motion pictures to county extension agents in the year ended June 30, 1931.

As in previous years, county extension agents frequently used exhibits to illustrate extension activities and results. Wherever possible, either men and women or boys and girls served as demonstrators with such exhibits.

The office of exhibits cooperated with the office of cooperative extension work and with State extension divisions in presenting a number of exhibits at State fairs. A particularly attractive cooperative exhibit was made in connection with Camp Vail at the Eastern States Exposition in September. This exhibit, covering various phases of 4-H club work, was housed in a large tent and pavilion located next to the dormitory for club delegates at Camp Vail. The subjects of the various booths were: New York, handicraft; Maine, clothing; Vermont, maple sugar; Rhode Island, 4-H cookies; Virginia, fruit drinks; Pennsylvania, beekeeping; Connecticut, vegetable canning; West Virginia, jam production; Massachusetts, novelties; Delaware, poultry; Maryland, fruit canning; and New Hampshire, garden.

The office of cooperative extension work in 1930 cooperated with State extension divisions in taking 954 field and 266 laboratory photographs. Photographic prints, slides, enlargements, charts, posters, and drawings to the number of 5,804 were requested and prepared for use in extension work. Twelve lantern-slide series and 33 film-strip series were prepared for extension use, and 12 lantern-slide series and 7 film-strip series previously prepared were revised.

RADIO

The national 4-H club program became firmly established as a monthly feature of the farm and home radio hour during the year. This program, broadcast on the first Saturday of each month from 12.30 to 1.30 p. m., eastern standard time, was established in August, 1929. During 1930 22 club members from 21 States, 5 county extension agents, 3 members of the State extension staff, 14 members of the department extension staff, and 2 persons not employed as extension workers contributed talks to the programs. The club members' talks were timely and interesting discussions of outstanding 4-H club achievement and unique features of club work. They were supplemented by inspirational talks from national, State, and county extension workers. The programs were also strengthened considerably by a music-appreciation period, in which a series of related compositions was played by the United States Marine Band and explained by R. A. Turner of the Department of Agriculture. This monthly program was broadcast over the coast-to-coast network of 45 radio stations associated with the National Broadcasting Co.

In November, the 4-H club radio program took the form of a joint Federal-State celebration of the completion of a year's 4-H club activities. In this national recognition of 4-H club achievement, 36 States cooperated by organizing and broadcasting over their local stations 30-minute State achievement-day programs which were preceded and followed by 15-minute Federal programs broadcast over the entire network. Other outstanding features of the year were a broadcast by club members from London, England, broadcasts of

activities from the National 4-H Club Camp at Washington, D. C., and broadcasts by club members from the International Livestock Exposition in Chicago.

EXHIBITS

The office of exhibits conducted exhibitions in 1930 at 74 fairs and exhibitions throughout the United States. (Table 5.) These showings included State fairs and special shows, such as the National Dairy Exposition, St. Louis; American Royal Livestock Show, Kansas City; International Livestock Exposition, Chicago; Chemical Industries Exposition, New York; and numerous miscellaneous exhibitions.

TABLE 5.—Exhibitions conducted during the fiscal year ended June 30, 1931

Place	Fair	Dates
Atlanta, Ga.	Southeastern Fair	Oct. 4-11, 1930.
Do.	Georgia Poultry, Rabbit, and Pigeon Show	Nov. 26-29, 1930.
Atlantic City, N. J.	American Fair	July 17-Aug. 27, 1930.
Baltimore, Md.	Maryland Poultry Products Show	Jan. 6-9, 1931.
Bethany, Mo.	Northwest Missouri State Fair	Sept. 2-6, 1930.
Billings, Mont.	Midland Empire Fair	Sept. 1-5, 1930.
Birmingham, Ala.	Alabama State Fair	Sept. 29-Oct. 4, 1930.
Boston, Mass.	Sports and Boat Show	Feb. 7-14, 1931.
Centerville, Md.	Annual Field Day, Maryland State Poultry Association.	June 18, 1931.
Charlottesville, Va.	Virginia State Dairymen's Convention	Jan. 27-30, 1931.
Chicago, Ill.	International Livestock Exposition	Nov. 29-Dec. 6, 1930.
Do.	Coliseum Poultry Show	Dec. 3-7, 1930.
Danbury, Conn.	Danbury Fair	Oct. 6-11, 1930.
Dallas, Tex.	State Fair of Texas	Oct. 11-26, 1930.
De Land, Fla.	Volusia County Fair	Feb. 17-21, 1931.
Detroit, Mich.	Michigan State Fair	Aug. 31-Sept. 6, 1930.
East Lansing, Mich.	Michigan State College Road Show	Oct. 28-30, 1930.
Enid, Okla.	Enid Road Show	Mar. 4-6, 1931.
Escanaba, Mich.	Upper Peninsula State Fair	Aug. 18-25, 1930.
Fayetteville, Ark.	Annual Field Day	Mar. 19, 1931.
Florence, S. C.	Pee Dee Fair	Sept. 29-Oct. 3, 1930.
Hagerstown, Md.	Hagerstown Fair	Sept. 16-20, 1930.
Hamline, Minn.	Minnesota State Fair	Aug. 30-Sept. 6, 1930.
Harrington, Del.	Kent-Sussex Fair	July 29-Aug. 2, 1930.
Helena, Mont.	Montana State Fair	Aug. 18-23, 1930.
Hutchinson, Kans.	Kansas State Fair	Sept. 13-19, 1930.
Indianapolis, Ind.	Indiana State Fair	Aug. 30-Sept. 6, 1930.
Johnson City, Tenn.	Appalachian District Fair	Sept. 8-13, 1930.
Kankakee, Ill.	Kankakee Interstate Fair	Aug. 11-16, 1930.
Kansas City, Mo.	American Royal Livestock Show	Nov. 15-22, 1930.
Knoxville, Tenn.	East Tennessee Division Fair	Sept. 20-27, 1930.
La Fayette, Ind.	Annual Road Show and School	Jan. 19-23, 1931.
Leipzig, Germany	International Fur Trade Congress	May 31-Sept. 30, 1930.
Lewiston, Me.	Maine State Fair	Sept. 1-4, 1930.
Lexington, Va.	Sixth Annual Highway Conference	Feb. 5-6, 1931.
Lincoln, Nebr.	Nebraska State Fair	Aug. 29-Sept. 5, 1930.
Little Rock, Ark.	Arkansas State Fair	Oct. 6-11, 1930.
London, England	Fourth World's Poultry Congress	July 22-30, 1930.
Los Angeles, Calif.	Fifth Annual Christmas Livestock Show	Nov. 29-Dec. 6, 1930.
Memphis, Tenn.	Mid-South Fair and Dairy Show	Sept. 20-27, 1930.
Milwaukee, Wis.	Wisconsin State Fair	Aug. 25-30, 1930.
Missoula, Mont.	Western Montana Fair	Sept. 16-19, 1930.
Moultrie, Ga.	Annual Hog School	Jan. 14-15, 1931.
Muskogee, Okla.	Oklahoma Free State Fair	Sept. 27-Oct. 4, 1930.
New York, N. Y.	Thirtieth Exposition of Chemical Industries	May 4-10, 1931.
Do.	Madison Square Garden Poultry Show	Jan. 14-18, 1931.
Omaha, Nebr.	Ak-Sar-Ben Stock Show	Oct. 31-Nov. 7, 1930.
Orlando, Fla.	Central Florida Exposition	Feb. 24-28, 1931.
Phoenix, Ariz.	Arizona State Fair	Nov. 10-15, 1930.
Prescott, Ariz.	Northern Arizona State Fair	July 2-5, 1930.
Puyallup, Wash.	Western Washington Fair	Sept. 15-21, 1930.
Raleigh, N. C.	North Carolina State Fair	Oct. 13-18, 1930.
Richmond, Va.	Virginia State Fair	Sept. 8-13, 1930.
Rochester, N. H.	Rochester Fair	Sept. 23-26, 1930.
Rochester, N. Y.	Rochester Exposition	Sept. 1-6, 1930.
St. Louis, Mo.	Washington University Engineers' Day	Mar. 20-21, 1931.
Do.	National Dairy Exposition	Oct. 11-19, 1930.

TABLE 5.—*Exhibitions conducted during the fiscal year ended June 30, 1931—Continued*

Place	Fair	Dates
Savannah, Ga.	Georgia State Fair	Oct. 27–Nov. 1, 1930.
Shreveport, La.	State Fair of Louisiana	Oct. 25–Nov. 2, 1930.
Spokane, Wash.	Spokane Interstate Fair	Sept. 1–6, 1930.
Springfield, Ill.	Illinois State Fair	Aug. 16–23, 1930.
Springfield, Mass.	Eastern States Exposition	Sept. 14–20, 1930.
Tampa, Fla.	South Florida Fair	Feb. 3–14, 1931.
Topeka, Kans.	Kansas Free Fair	Sept. 8–12, 1930.
Trenton, N. J.	Trenton Interstate Fair	Sept. 1–6, 1930.
Waco, Tex.	Texas Cotton Palace and Dairy Show	Oct. 10–19, 1930.
Washington, D. C.	Sixth Annual Industrial Exposition	Nov. 3–8, 1930.
Do.	United States Pharmacopœial Convention	May 12–17, 1931.
Do.	Howard University Health Week	Apr. 27–May 2, 1931.
Waterloo, Iowa.	Dairy Cattle Congress	Sept. 29–Oct. 5, 1930.
Wichita, Kans.	Southwest Road Show and School	Feb. 24–27, 1931.
Do.	Western Tractor and Farm Power Equipment Show	Do.
Wilson, N. C.	Wilson County Fair	Oct. 18–25, 1930.
Yakima, Wash.	Washington State Fair	Sept. 8–13, 1930.

Eighteen exhibition groups were sent out on State and interstate fair circuits during the year, the material for the exhibits having been selected with special reference to the agricultural interests of the areas in which they were shown. The exhibits represented the department interests in dairying, livestock, forestry, roads, predatory animals and rodents, poultry, marketing, home economics, weather, farm management, and boys' and girls' club work. In addition, special groups were prepared for the National Dairy Exposition in St. Louis, the Eastern States Exposition, Springfield, Mass., and the International Livestock Exposition in Chicago. The special poultry exhibit displayed at the Fourth World's Poultry Congress, London, England, in July, was also displayed at the St. Louis National Poultry Show, the National Dairy Exposition in St. Louis, and the Chicago Coliseum Poultry Show. The material for the 74 fairs and exhibitions required 31 carload and 36 less-than-carload shipments in the outgoing movement, and 29 carload and 27 less-than-carload shipments were received. The total of 60 carload and 63 less-than-carload shipments were handled in or out of the exhibits factory-warehouse at Alexandria, Va.

Forty-six exhibitions were made at State, interstate, and international fairs, as compared with 45 in 1920, 40 in 1928, 37 in 1927, and 35 in 1926. No less than a carload of material was shown at each of these exhibitions. Data on personnel cost at fairs are found in Table 6.

TABLE 6.—*Exhibition personnel costs at State, interstate, and international fairs, 1926–1930*

Item	1926	1927	1928	1929	1930
Exhibitions.....number	35	37	40	45	46
Man-days.....do	1, 172	943	877	1, 131	1, 094
Total department salary cost.....dollars	8, 636.54	6, 450.32	6, 319.39	8, 343.00	7, 726.69
Total department travel and subsistence cost.....do	12, 472.81	7, 875.78	6, 685.45	9, 117.75	7, 965.19
Cost per exhibition.....do	603.12	387.10	325.12	388.02	341.13

The exhibition appropriation of \$120,000 available during the fiscal year 1930 was the same as that for 1929. No change was made in the cooperative arrangements with the bureaus of the department concerning the payment of travel and subsistence expenses of exhibition personnel, the office of exhibits and the bureaus each having agreed to pay half of the expenses.

COOPERATION WITH FAIRS

The cooperative exhibition plan which has been in effect for several years was continued. Under this plan the department provides the exhibits and personnel for their installation and demonstration. The fairs furnish the transportation by deposit in advance, exhibition space, storage for shipping containers, drayage and labor for unloading and reloading cars; common labor for unpacking, installing, dismantling, and repacking exhibits; janitor, watchman, electrical, and such other services as are necessary to make a creditable display.

As a result of the continued efforts by the office of exhibits to reduce transportation costs to the fairs and at the same time to shorten the periods of inactivity of the displays between exhibitions, it has been possible to further reduce by \$5 the amount of deposit required from fairs to cover transportation costs. The deposit for the 1931 showing season has been placed at \$160 per carload per fair, which represents a saving of \$25 per fair since 1926, when the transportation cost was \$185. The cooperation given by fairs may be summarized as follows:

Deposits to cover transportation charges-----	\$9,335.92
Value of exhibition space (estimated)-----	41,000.00
Trucking (unloading and loading exhibits)-----	1,288.26
Installation and dismantling labor-----	1,137.25
Miscellaneous exhibit expenses-----	644.35
Total-----	53,405.78

The standing committee on Government exhibits, of the International Association of Fairs and Expositions, met in Washington, March 23 and 24, 1931, and commended the office of exhibits for its continued progress in preparing valuable information in the form of exhibits and placing it at the disposal of agricultural fairs. They again recommended the employment of a capable extension specialist to assist the agricultural colleges, State departments of agriculture, and State associations of fairs, in preparing desirable exhibits within the several States, and recommended that the scattered exhibit functions of the department be coordinated into one effective central exhibit agency. The committee, likewise, renewed its recommendation to the Secretary of Agriculture for an appropriation of \$225,000 to carry out the enlarged exhibit program as recommended by committees of the international association for the last three years.

PARTICIPATION IN FOREIGN EXHIBITIONS

The department participated, under special Congressional appropriations, in two major international expositions in Europe.

At the International Fur Trade Exhibition and Congress held in Leipzig, Germany, May 30 to September 30, 1930, there was displayed

an exhibit portraying the development of the fur industry of the United States, the production, conservation, and utilization of fur as a natural resource. The importance of forests as the natural habitat of fur-bearing animals was also demonstrated.

The second foreign exhibit was displayed in the Crystal Palace at the Fourth World's Poultry Congress held in London, England, July 22 to 30, 1930. It set forth the fundamental factors in the poultry industry in the United States and occupied 2,880 square feet of space. It portrayed breeding for egg production, history of incubation and brooding, nutrition of poultry (talking hen), the poultry industry of the United States, marketing eggs, and marketing poultry. This entire exhibit, particularly the talking hen, proved very popular with visitors to the congress, and since its return to the United States has been shown as a whole or in part on nine occasions.

PREPARATION OF EXHIBITS

During the year the equivalents of 40 exhibit units were prepared, those of 34 were discarded, those of 33 were extensively revised or rebuilt, and those of 166 were renovated. Fewer new exhibits were built, but more attention was given to the improvement of existing units.

Fairs and expositions using department exhibits, through their national organization, now insist that the exhibits offered them meet certain qualifications before the fair organizations make the necessary investment of money and space required. These qualifications are: (1) Usefulness of information to people of the region served by the fair; (2) timeliness of information; (3) interest power, i. e., ability of exhibit to get its message into the minds of the audiences; and (4) attractiveness of appearance.

In view of this fact all existing exhibits were closely scrutinized. Those which had proved successful were retained, 33 which showed possibilities were revised, and 34 weaker units were discarded and their usable parts salvaged for use in future exhibits. In examining the effectiveness of a number of the exhibits the services of a prominent psychologist were utilized, and a number of his suggestions were employed in improving these units. In the revision of existing exhibits an effort has been made to attain terseness of expression, and in one group of eight exhibits, 1,608 words were eliminated.

It is becoming increasingly evident that the mere introduction of motion or action will not suffice in obtaining interest power and effectiveness of presentation. There must be actual mechanization of ideas, that is, the action must aid in clarifying the thought.

Motion used only as an eye catcher does not hold the attention long and does not move ideas from exhibit to audience. Also it is soon recognized as a trick and such recognition lowers the standing of the exhibiting organization in the mind of the thoughtful observer.

A new development in the appearance of the exhibits was the assignment of a distinctive color to each of the 18 exhibit groups. The woodwork, trim, and hangings of the entire group were thus made to harmonize. As these different groups are shown at a certain fair they will present a different appearance from year to year aside from differences in subject-matter content.

Improvement in mechanical design has been gained through study by the engineering section of new methods and equipment developed by commercial concerns and presented at technical institutes, such as the Westinghouse Electric Institute. As a further method of improving exhibit construction the advice of a local consulting mechanical engineer was obtained.

An unusual feature of the department's exhibit at the National Dairy Exposition, St. Louis, was a breeding school and demonstration herd brought from the dairy experimental farm at Huntley, Mont., which brought requests for similar schools from a majority of the States.

Near the end of the year the new quarters of the office of exhibits became available and the remaining renovation work was completed there.

An outstanding development of the year's activities was the marked increase in requests for assistance in planning and preparing exhibits, and for building duplicates of some of the department's newer exhibits on a cost basis, such service being sought by commercial, educational, and State institutions. A total of 37 requests for planning help, 34 requests for publications, and 28 requests for plans, specifications, and photographs of the mechanical hen have been met so far as time and resources permitted. There is, however, no way to meet the demand for exhibit-building service, and thus extend the usefulness of this office by providing exhibits for use at the numerous smaller fairs and conventions which can not be reached by the department's exhibition program.

NEW PROJECTS

A comprehensive department exhibit on wool production, marketing, and utilization was planned, and four units were under construction at the close of the year. Subject matter for a department exhibit on all phases of cotton production, marketing, and utilization was received, and the development of plans was begun.

FUNDS AND PERSONNEL

Under the direction of the office of exhibits an appropriation of approximately \$120,000 was spent for exhibits at State, interstate, and international fairs. The addition of \$9,168.92 in deposits makes a total of \$129,168.92 for exhibit activities.

In addition, nine units of the department contributed to this office the sum of \$1,178.44 for work performed in connection with occasions not eligible to participate in the appropriation for fair exhibits. This work consisted of renovating, repairing, trucking, shipping, and replacing in storage exhibit material displayed at occasions not within the provisions of the exhibit appropriation act.

No important changes in personnel occurred during the year. The personnel in Washington at the end of the year numbered 30, and in Alexandria, Va., 11. Emergency employment for varying periods during the year totaled 13.

CHANGE IN WAREHOUSING FACILITIES

In February, 1931, negotiations with the Navy Department were completed and space for the exhibit factory and warehouse facilities

of the office of exhibits at Alexandria, Va., was assigned in the Naval Torpedo Station. On June 30 the department exhibit activities at Alexandria were transferred from the Portner Building to the fourth floor of the Naval Torpedo Station. The new space is well adapted for the department's purposes. It consists of approximately 48,000 square feet of floor surface, about 7,000 square feet more than was afforded by the former quarters. The change will increase the efficiency of the exhibit activities through savings in trucking and handling costs. Cars can now be loaded and unloaded at the Naval Torpedo Station building, whereas at the old location it was necessary to truck material a considerable distance. The new quarters also provide improved working conditions and may result in some saving in direct money outlay.

MOTION PICTURES

During the year 31 new films were completed and released, including 3 talking pictures, the first sound films that the Department of Agriculture has released. (Table 7.) A total of 185 copies of these 31 pictures have been provided for loan to extension workers and to the general public.

TABLE 7.—*New motion pictures completed during fiscal year 1931*

Title of picture	Reels made	Copies made
	Number	Number
Sound pictures:		
Sago Making in Primitive New Guinea (1 reel).....	1	1
The Babcock Test (1 reel).....	1	1
Forest or Wasteland? (2 reels).....	2	1
Silent pictures:		
Highways of Uruguay (1 reel).....	3	3
Highways of Chile (2 reels).....	6	3
Highway Glimpses of Panama (2 reels).....	6	3
Highway Glimpses of Trinidad (1 reel).....	3	3
Highways of Venezuela (2 reels).....	6	3
Highway Glimpses of Colombia and Dutch West Indies (1 reel).....	3	3
Food Makes a Difference (2 reels).....	12	6
Why Moths Leave Home (1 reel).....	15	15
Quality Milk (1 reel).....	9	9
Mixed-in-Place Bituminous Surfaces (2 reels).....	8	4
Penetration Bituminous Macadam (1 reel).....	4	4
Forest Fires—or Game? (1 reel).....	21	21
Unburned Woodlands (1 reel).....	13	13
Cooperative Marketing—Dried Prunes (2 reels).....	14	7
Back of the Weather Forecast (2 reels).....	14	7
What Price Fire? (2 reels).....	2	1
Hot-Mixed Bituminous Pavements (1 reel).....	4	4
How to Grow Hogs (2 reels).....	18	9
Fighting the European Corn Borer with Machinery (1 reel).....	3	3
Good Posture Wins (2 reels).....	14	7
Forests and Streams (1 reel).....	11	11
Timber-r-r (1 reel).....	1	1
Testing Seeds in Soil (1 reel).....	2	2
Forest or Wasteland? (3 reels).....	36	12
How Seeds Germinate (1 reel).....	1	1
The Cougar Hunt (1 reel).....	11	11
Highways of Peru (2 reels).....	6	3
How Forests Serve (1 reel).....	13	13
Total.....	263	185

The total number of shipments of standard-width film made during the year was 2,880, a falling off of nearly 15 per cent, as compared with the shipments during the preceding fiscal year. This decline is attributable largely to the fact that the demand for silent

pictures has tended to abate since the advent of talking pictures. In spite of this relative falling off in demand, 615 applications for loans could not be filled, because of lack of copies of the films desired. Experimental circulation of some 30 subjects on 16-millimeter stock developed a relatively small demand from extension workers. This service will be continued, however, and will be extended in accordance with demand and with funds available.

Radical changes in the organization of the staff of the office of motion pictures were made during the year, with a view to handling more efficiently the steadily increasing volume of business. Under the reorganization plan, four divisions have been created: A division of operation, to handle personnel and business matters; a division of production, to handle motion-picture projects from the standpoint of scenario, direction, and editing; a laboratory division, to handle processing operations; and a circulation division responsible for the booking and shipment of films on loan.

Sound-on-film equipment for both projection and recording was installed during the year, and the projection room of the motion-picture building on C Street was sound-proofed to serve as a temporary sound studio. There the recording of voice for lecture pictures is going forward.

Statistics on pictures purchased by outside agencies are presented in Table 8.

TABLE 8.—*Summary of department motion pictures purchased by outside agencies*

Bureau sponsoring subject matter of film	Number of reels		Number of prints	
	Domestic purchases	Foreign purchases	Domestic purchases	Foreign purchases
Agricultural Economics.....	20	1	9	1
Animal Industry.....	25	16	19	12
Biological Survey.....	17	0	13	0
Dairy Industry.....	93 $\frac{1}{4}$	2	14	3
Entomology.....	15	4	14	3
Extension Service.....	14	8	8	6
Forest Service.....	65	17	48	14
Home Economics.....	8	2	4	1
Plant Industry.....	29	12	25	10
Public Roads.....	37	21	29	16
Weather Bureau.....	9	-----	5	-----
Total.....	{ 248 $\frac{3}{4}$ 83		188	66
	{ 331 $\frac{3}{4}$		254	

APPENDIX

[Funds for extension work are appropriated for fiscal years ending June 30, whereas extension agents are required to prepare their reports for calendar years. For this reason the statements of funds expended are for the fiscal year ended June 30, 1930, and the statistics of results of work done are for the calendar year ended November 30, 1930]

TABLE 9.—*Results of cooperative extension work, 1930*

Project or line of work	Reported by county agricultural agents		Reported by home demonstration agents		Reported by club agents ¹		Total of all lines of work	
	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number
County associations fostering extension work.....	2, 024	2, 249	1, 018	1, 171	99	125	3, 141	3, 545
Membership in these associations.....	1, 899	512, 457	958	174, 199	81	18, 132	2, 948	704, 788
Communities in counties.....	2, 435	48, 196	1, 325	39, 992	181	8, 580	3, 941	96, 708
Communities with extension program.....	2, 196	32, 260	1, 287	27, 388	165	5, 740	3, 648	65, 388
Voluntary local leaders:								
Men leaders in adult work.....	2, 217	127, 413	122	2, 327	7	152	2, 346	129, 892
Women leaders in adult work.....	1, 198	33, 041	1, 135	69, 931	10	179	2, 343	103, 151
Men leaders in junior work.....	1, 841	17, 359	1, 001	1, 001	186	2, 939	2, 187	21, 299
Women leaders in junior work.....	1, 362	15, 277	1, 002	17, 385	173	6, 145	2, 537	38, 807
Older club boy leaders in junior work.....	1, 162	8, 763	1, 07	17, 674	151	977	1, 420	10, 414
Older club girl leaders in junior work.....	752	4, 529	745	9, 235	142	1, 060	1, 639	14, 824
Clubs or other groups organized to carry on adult home demonstration work.....	684	11, 687	1, 307	23, 171	5	101	1, 906	34, 959
Membership in such clubs or groups.....	671	200, 980	1, 288	444, 806	4	854	1, 960	646, 340
Junior clubs.....	2, 088	27, 208	1, 200	18, 189	212	10, 783	3, 500	56, 180
Enrollment—								
Boys.....	2, 257	263, 128	220	8, 487	206	61, 582	2, 683	333, 197
Girls.....	1, 618	142, 727	1, 211	274, 438	205	72, 352	3, 034	489, 517
Completions—								
Boys.....	2, 184	172, 324	205	5, 608	202	44, 540	2, 561	222, 472
Girls.....	1, 532	103, 876	1, 168	170, 783	200	57, 214	2, 900	331, 873
Club members in school.....		7		95		7		94
Club members not in school.....	1, 408	6, 110	557	4, 687	180	1, 736	2, 205	12, 533
Junior judging teams trained.....	1, 253	10, 262	824	11, 202	147	2, 060	2, 224	23, 524
Groups organized for extension work with rural young people above club age.....	1, 176	538	99	328	25	46	300	912
Membership in such groups.....	164	7, 640	92	5, 097	18	703	274	13, 440
Farm visits made.....	2, 550	1, 657, 554	178	20, 013	182	81, 176	2, 910	1, 758, 743
Different farms visited.....	2, 549	855, 500	176	12, 054	182	42, 461	2, 907	910, 015
Home visits made.....	2, 923	109, 653	1, 358	407, 311	133	29, 244	2, 414	546, 208
Different homes visited.....	923	73, 593	1, 356	239, 257	133	17, 234	2, 412	330, 084
Office calls.....	2, 534	3, 669, 422	1, 352	588, 961	184	59, 184	4, 070	4, 317, 565
Telephone calls.....	2, 452	2, 344, 969	1, 315	591, 339	185	79, 399	3, 952	3, 015, 707
Time in field.....		66		68		66		67

See footnotes at end of table.

TABLE 9.—*Results of cooperative extension work, 1930*—Continued

Project or line of work	Reported by county agricultural agents		Reported by home demonstration agents		Reported by club agents ¹		Total of all lines of work	
	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number
Time in office.....	2 505	2 34	1 321	2 32	189	2 34	4 015	1 33
News articles prepared for press.....	2 532	320,786	1 358	109,173	191	19,895	4,501,988	449,854
Individual letters written.....	2 413	3,202,978	1 275	1,142,209	166	156,801	4,081	4,501,988
Different circular letters prepared.....	2 465	141,836	1 301	60,192	168	354,271	3,856	214,561
Bulletins distributed.....	2 496	3,702,186	220	2,601,104	166	354,271	3,856	6,657,561
Radio talks made.....	1 956	7,863	1 199	10,688	56	1,955	3,772	3,772
Events at which extension exhibits were shown.....	1 395	16,692	949	12,688	170	1,955	3,772	20,476
Adult leader-training meetings held.....	1 122	198,683	939	137,251	13	3,109	2,357	29,439
Junior leader-training meetings held.....	1 364	7,375	723	4,543	10	3,107	2,071	339,011
Method demonstration meetings held.....	2 239	86,163	714	55,131	172	1,546	2,259	13,464
Attendance.....	2 214	3,033,605	1 302	234,415	169	21,994	2,245	163,288
Result demonstration meetings held.....	1 889	37,780	1 287	3,956,873	168	228,645	3,710	402,458
Tours conducted.....	1 876	895,795	803	24,357	92	4,231	2,784	7,219,123
Attendance.....	1 705	5,854	620	523,233	91	97,409	2,764	66,368
Achievement days held for adults.....	1 701	299,715	618	2,090	148	828	2,473	1,516,437
Attendance.....	573	1,293	680	118,041	148	24,177	2,467	441,933
Achievement days held for juniors.....	1 341	283,393	674	225,671	11	26	1,264	3,015
Attendance.....	1 331	6,525	806	3,102	175	3,352	1,250	512,416
Women's club encampments held.....	1 132	638,748	801	308,120	175	2,078	2,322	11,705
Attendance.....	121	16,089	485	47,414	6	179,517	2,307	1,126,385
Junior club encampments held.....	1 269	1,707	733	77,982	5	589	611	64,072
Attendance.....	1 259	330,287	729	77,889	123	209	2,125	64,072
Meetings held by agents.....	2 239	370,208	1 302	334,260	124	18,663	2,115	2,898
Attendance.....	2 214	15,161,523	1 287	9,075,153	175	45,911	3,716	226,839
Adult meetings held by local leaders not participated in by agent.....	952	48,144	707	45,144	175	1,308,809	3,676	750,379
Attendance.....	945	855,853	701	577,537	6	257	1,665	25,605,465
Junior meetings held by local leaders not participated in by agent.....	1 050	62,123	585	39,737	7	11,842	1,653	93,545
Attendance.....	1 045	1,043,957	583	531,278	114	38,203	1,749	1,445,232
Corn:					115	546,636	1,743	38,203
Adult result demonstrations.....	1 654	28,405						1,460
Junior projects completed ³	1 367	29,451	4	62	6	34	1,660	28,439
Wheat:					89	1,938	1,460	31,451
Adult result demonstrations.....	910	10,777			1	5	911	10,782
Junior projects completed ³	88	502			4	7	92	509
Oats:								
Adult result demonstrations.....	962	10,327			2	32	964	10,359
Junior projects completed ³	82	518					82	518

Rye:	356	7,611	356	356	7,611
Adult result demonstrations.....	4	33	4	33	33
Junior projects completed 3.....					
Barley:					
Adult result demonstrations.....	530	3,719	2	24	532
Junior projects completed 3.....	46	134	2	10	144
Other cereals:					
Adult result demonstrations.....	336	4,434	6	274	336
Junior projects completed 3.....	178	2,451			184
Alfalfa:					
Adult result demonstrations.....	1,288	15,068	4	21	1,292
Junior projects completed 3.....	57	468	13	117	70
Sweetclover:					
Adult result demonstrations.....	840	6,714	2	9	842
Junior projects completed 3.....	15	34			13
Clovers (red, alsike, and white):					
Adult result demonstrations.....	491	5,695	2	36	493
Junior projects completed 3.....	5	14	1	1	6
Vetch:					
Adult result demonstrations.....	575	12,352	1	4	576
Junior projects completed 3.....	43	516			43
Lespedeza:					
Adult result demonstrations.....	607	7,305	2	28	609
Junior projects completed 3.....	20	61			20
Pastures:					
Adult result demonstrations.....	1,178	14,178	1	8	1,179
Junior projects completed 3.....	36	233	1	4	37
Soybeans:					
Adult result demonstrations.....	994	16,854	1	12	995
Junior projects completed 3.....	180	1,208	3	17	183
Cowpeas:					
Adult result demonstrations.....	480	8,108			480
Junior projects completed 3.....	111	1,038			111
Velvetbeans:					
Adult result demonstrations.....	240	3,514			240
Junior projects completed 3.....	8	41			8
Field beans:					
Adult result demonstrations.....	171	1,002	3	256	171
Junior projects completed 3.....	51	364	20	74	651
Peanuts:					
Adult result demonstrations.....	265	2,980			265
Junior projects completed 3.....	340	3,086	7	117	347
Other legumes and forage crops:					
Adult result demonstrations.....	366	5,079			366
Junior projects completed 3.....	43	280	2	16	45
Potatoes:					
Adult result demonstrations.....	965	11,079			969
Junior projects completed 3.....	706	9,159	4	11	838
Sweetpotatoes:					
Adult result demonstrations.....	513	6,081			514
Junior projects completed 3.....	372	3,032	1	12	387

See footnotes at end of table.

TABLE 9.—Results of cooperative extension work, 1930—Continued

Project or line of work	Reported by county agricultural agents		Reported by home demonstration agents		Reported by club agents ¹		Total of all lines of work	
	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number
Cotton:								
Adult result demonstrations.....	787	32,692			2	10	789	32,702
Junior projects completed ³	704	22,631			8	719	712	23,350
Tobacco:								
Adult result demonstrations.....	289	4,625			1	2	290	4,627
Junior projects completed ³	183	4,298			7	230	190	4,528
Other special crops:								
Adult result demonstrations.....	209	2,575					209	2,575
Junior projects completed ³	92	975			9	87	101	1,062
Home gardens:								
Adult result demonstrations.....	484	15,455	632	49,150	3	98	1,119	64,703
Junior projects completed ³	538	12,595	591	48,616	149	12,457	1,278	73,668
Market gardens:								
Adult result demonstrations.....	590	9,234	159	5,872	2	12	751	15,118
Junior projects completed ³	208	2,424	99	5,920	26	789	333	9,133
Beautifying home grounds:								
Adult result demonstrations.....	595	7,721	608	34,022	5	25	1,208	41,768
Junior projects completed ³	139	3,903	374	29,760	30	859	543	34,522
Tree fruits:								
Adult result demonstrations.....	1,135	20,383	116	3,901	2	8	1,253	24,292
Junior projects completed ³	96	519	60	1,835	13	153	169	2,507
Bush and small fruits:								
Adult result demonstrations.....	333	1,995	104	3,539	1	7	438	5,541
Junior projects completed ³	57	602	61	2,102	36	263	154	2,967
Grapes:								
Adult result demonstrations.....	410	1,943	67	1,045	1	5	478	2,993
Junior projects completed ³	16	109	42	817	2	28	60	954
Forestry:								
Adult result demonstrations.....	660	5,709	3	29	3	10	666	5,743
Junior projects completed ¹	138	2,413	3	71	87	2,895	228	5,379
Forest or wood-lot plantings made.....	373	4,469	1	1	55	999	429	5,469
Farms on which assistance was given in forest or wood-lot management.....	534	6,010			21	160	555	6,170
Farms on which windbreaks were planted.....	291	3,825			7	47	298	3,872
Farms on which attempts were made to control white-pine blister rust.....	37	918			4	50	41	968
Farms on which other assistance was given relative to forestry.....	219	9,071			7	48	226	9,119
Redstarts:								
Adult result demonstrations.....	412	9,450	10	179			422	9,629
Poison bait used.....	578	1,154,679	10	4,899	1	45		1,155,583

Other animal pests:	150	1,545	7	156	157	1,701
Adult result demonstrations:	141	4129, 929	3	4 24	144	4129, 953
Poison bait used:						
Adult result demonstrations:	490	19,783	36	1,777	427	21,561
Poison bait used:	560	44,406, 927	35	42,686	585	44,409, 613
Rural engineering:						
Adult result demonstrations:	1,129	25,904	132	2,753	1,263	28,665
Junior projects completed:	197	3,665	32	2,512	20	6,701
Farms on which drainage systems were installed:	923	6,369	10	42	534	249
Farms on which irrigation systems were installed:	349	2,727	1	5	933	6,411
Farms on which terraces and soil-saving dams were built:	1,085	46,247	2	15	2	350
Farms on which land was cleared of stumps or bowlders:	587	12,570	9	79	1,089	46,274
Families assisted with house-planning problems:	486	3,428	294	6,754	596	12,646
Dwellings constructed according to plans furnished:	340	1,155	174	669	780	9,182
Dwellings remodeled according to plans furnished:	277	1,333	260	1,550	514	1,824
Sewage-disposal systems installed according to plans furnished:	700	2,908	188	1,999	537	2,883
Water systems installed according to plans furnished:	632	2,445	272	1,764	890	3,911
Heating systems installed according to plans furnished:	96	235	106	404	905	4,211
Lighting systems installed according to plans furnished:	296	3,001	192	1,930	202	639
Farms on which buildings other than dwellings were constructed or remodeled according to plans furnished:	2,022	40,472	260	3,548	488	4,931
Poultry:						
Adult result demonstrations:	1,589	51,665	485	21,616	2,292	44,124
Junior projects completed:	1,338	34,611	502	18,637	36	73,317
Farms on which assistance was given in obtaining purebred cockerels:	1,213	18,671	123	2,894	8,271	61,519
Farms on which assistance was given in obtaining high-grade or purebred females:	888	17,301	124	4,780	162	21,727
Cockerel circles or clubs organized:	26	37	21	24	37	22,720
Membership in such circles or clubs:	24	428	21	1,154	2	1,049
Flock-improvement associations organized or reorganized:	282	445	65	111	46	1,598
Membership in such associations:	266	8,884	61	2,760	2	349
Farms whose operators were not in associations keeping performance records of birds:	683	11,551	51	2,381	78	558
Dairy cattle:						
Adult result demonstrations:	1,241	25,944	72	2,555	741	14,157
Junior projects completed:	1,472	28,248	71	383	55	28,554
Farms on which assistance was given in obtaining purebred sires:	1,752	13,316	14	104	7,923	36,554
Farms on which assistance was given in obtaining high-grade or purebred females:	1,462	16,000	13	160	1,812	13,591
Bull circles or clubs organized:	240	599	5	5	662	16,822
Membership in such circles or clubs:	225	6,532	5	2	1,543	2,247
Herd-improvement associations organized or reorganized:	916	1,426	2	45	2	6,608
Membership in such associations:	907	31,537	2	19	31	923
Farms whose operators were not in associations keeping performance records of animals:	807	16,212	11	283	100	31,656
Beef cattle:						
Adult result demonstrations:	636	4,092			113	16,608
Junior projects completed:	820	11,461	16	25	636	4,092
Farms on which assistance was given in obtaining purebred sires:	1,025	5,838	84	1,293	920	2,779
			5		1,030	5,845

See footnotes at end of table.

TABLE 9.—*Results of cooperative extension work, 1930—Continued*

Project or line of work	Reported by county agricultural agents		Reported by home demonstration agents		Reported by club agents ¹		Total of all lines of work	
	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number
Beef cattle—Continued.								
Farms on which assistance was given in obtaining high-grade or purebred females.....	505	3, 167			7	24	512	3, 191
Bull circles or clubs organized.....	33	102	1	1	1		35	105
Membership in such circles or clubs.....	20	233	1	16		2	21	249
Herd-improvement associations organized or reorganized.....	42	71					42	71
Membership in such associations.....	38	2, 130					38	2, 130
Farms whose operators were not in associations keeping performance records of animals.....	107	637					107	637
Sheep:								
Adult result demonstrations.....	595	8, 293	1	1	2	9	598	8, 303
Junior projects completed ²	725	6, 392	1	6	123	1, 794	849	8, 392
Farms on which assistance was given in obtaining purebred sires.....	980	7, 098			16	58	996	7, 156
Farms on which assistance was given in obtaining high-grade or purebred females.....	626	3, 273			23	125	649	3, 398
Ram circles or clubs organized.....	25	96			2	4	27	100
Membership in such circles or clubs.....	17	307					17	307
Flock-improvement associations organized or reorganized.....	48	54					48	54
Membership in such associations.....	47	2, 771					47	2, 771
Farms whose operators were not in associations keeping performance records of animals.....	102	1, 958					102	1, 958
Swine:								
Adult result demonstrations.....	997	12, 374	2	19	12	16	1, 011	12, 409
Junior projects completed ²	1, 573	31, 942	10	254	153	3, 883	1, 736	36, 079
Farms on which assistance was given in obtaining purebred sires.....	1, 380	11, 707	3	21	19	72	1, 402	11, 800
Farms on which assistance was given in obtaining high-grade or purebred females.....	1, 056	14, 134	1	6	37	295	1, 094	14, 435
Boar circles or clubs organized.....	43	137	1	1	2	5	46	143
Membership in such circles or clubs.....	28	757	1	8	1	12	30	777
Herd-improvement associations organized or reorganized.....	28	36					28	36
Membership in such associations.....	24	924					24	924
Farms whose operators were not in associations keeping performance records of animals.....	171	1, 582	1	23	1	6	173	1, 611
Horses and mules:								
Adult result demonstrations.....	85	604			1	18	86	622
Junior projects completed ²	78	444			9	96	87	540
Farms on which assistance was given in obtaining purebred sires.....	94	277	1	2			95	279
Farms on which assistance was given in obtaining high-grade or purebred females.....	49	215			1	1	50	216
Stallion circles or clubs organized.....	28	35					28	35

Membership in such circles or clubs.....	28	838							28	838
Herd-improvement associations organized or reorganized.....	11	12							11	12
Membership in such associations.....	11	266							11	266
Farms whose operators were not in associations keeping performance records of animals.....	7	64							7	64
Farm management, credit, insurance, and taxation:										
Adult result demonstrations.....	656	13,376	10	610	2	33			668	14,019
Junior projects completed.....	104	5,486	8	338	11	624			123	6,448
Farms on which farm accounts were kept.....	1,108	22,387	5	28	7	101			1,120	22,516
Farms on which cost-of-production records were kept.....	1,088	19,552	3	14	2	7			885	19,573
Farms on which assistance was given in summarizing and interpreting accounts.....	1,017	19,467	3	16	3	29			1,023	19,512
Farms on which assistance was given in making inventory or credit statements.....	775	20,205	3	34	6	53			784	20,292
Farms on which changes in business were made as result of keeping accounts or survey records.....	426	20,468	2	3					428	20,471
Other farms on which cropping, livestock, or complete farming systems were adopted.....	803	16,779	1	2	2	2			806	16,783
Farms on which advice relative to leases was given.....	848	40,855							848	40,855
Farms on which assistance in obtaining credit was given.....	1,094	10,665			1				1,095	10,667
Different farms on which assistance was given in the use of outlook or other timely economic information as a basis for readjusting farm operations.....	1,057	33,108	1	2	1	2			1,059	33,112
Marketing:										
Cooperative marketing associations organized during the year.....	1,300	134,644	38	1,271	3	28			1,341	135,943
Cooperative marketing associations previously organized.....	187	1,557	22	126	1	2			210	1,685
Membership in such associations.....	601	7,172	88	364	1	3			690	7,539
Value of products marketed.....	469	818,254	86	38,894					555	857,148
Value of supplies purchased.....	295	986,825	91	1,707,515					580	2,97,094,340
Associations assisted with problems of—	320	\$42,924,560	18	\$45,012					338	\$42,969,572
Preliminary analysis.....	158	1,616	9	30	1	2			168	1,648
Organization.....	252	2,230	20	155					272	2,385
Accounting and auditing.....	133	1,041	14	60					147	1,101
Financing.....	125	1,273	11	56					136	1,329
Business policies.....	248	2,273	22	84					270	2,357
Production to meet market demand.....	229	2,131	30	121					252	2,252
Reduction of market losses.....	166	1,622	12	32					178	1,654
Use of current market information.....	299	2,892	25	107					324	3,039
Standardizing.....	257	1,789	20	202					291	1,991
Processing or manufacturing.....	51	244	13	92					64	336
Packaging and grading.....	278	1,433	26	135					304	1,568
Loading.....	190	1,032	17	35					207	1,067
Warehousing.....	142	834	3	11	1				146	846
Keeping members informed.....	80	534	2	3					82	537
Merging into larger units.....	349	3,284	26	126					375	3,410
Farms or homes whose operators were not in associations assisted with problems of standardizing.....	80	963	4	42					84	1,005
Farms or homes whose operators were not in associations assisted with problems of packaging and grading.....	166	27,665	64	11,143					230	38,808
See footnotes at end of table.	217	24,501	43	7,475	1	7			261	31,983

TABLE 9.—*Results of cooperative extension work, 1930—Continued*

Project or line of work	Reported by county agricultural agents		Reported by home demonstration agents		Reported by club agents ¹		Total of all lines of work	
	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number
Marketing—Continued.								
Farms or homes whose operators were not in associations assisted with problems of use of current market information.								
Food and nutrition:								
Adult result demonstrations	263	89,320	36	6,609	1	4	300	95,933
Junior projects completed in food selection and preparation ³	103	10,280	772	88,479	2	7	877	98,776
Junior projects completed in food preservation ²	414	13,431	864	83,220	151	14,186	1,429	110,837
Homes in which assistance was given in planning family food budget.	315	6,815	823	69,688	139	5,902	1,277	82,405
Homes in which food expenditures were budgeted.	94	13,158	635	59,852	11	386	740	73,396
Homes in which family meals were balanced.	49	2,742	343	12,479	3	119	395	15,340
Homes in which home-packed lunches were improved.	107	18,253	674	76,919	7	428	788	95,600
Schools in which recommendations for a hot dish or school lunch were followed.	87	5,204	771	61,690	54	2,509	912	69,403
Homes in which improved methods in child feeding were used.	110	718	566	4,547	52	648	728	5,913
Individuals adopting recommendations for corrective feeding.	98	13,332	682	56,507	7	403	787	70,242
Jars of canned products preserved by junior club members.	85	13,134	647	63,410	13	637	745	81,181
Child training and care:	286	328,866	862	2,789,044	122	386,501	1,270	3,504,411
Adult result demonstrations			198	8,107			205	8,621
Junior projects completed ³	7	514	62	4,495	3	13	65	4,508
Homes in which—								
Habits of school children were improved.								
Positive methods of discipline were substituted for negative ones.	16	3,081	200	13,978	1	8	217	17,067
Play equipment was provided.	11	1,332	178	7,943			189	9,275
Physical adjustments were made to better meet children's needs.	6	740	171	3,768			177	4,508
Better adult habits were adopted with respect to development of children.	13	579	206	8,544			219	9,123
Clothing:								
Adult result demonstrations	14	1,890	218	13,416			232	15,306
Junior projects completed ³	84	5,271	629	83,681			713	88,952
Women improving construction of clothing	675	53,814	1,040	124,954	168	30,888	1,883	209,656
Women using a clothing budget.	103	27,076	915	146,778	1	150	1,079	174,004
Women making garments for themselves.	35	1,539	300	12,335			335	13,889
Women improving children's clothing	136	18,086	940	144,551			1,078	163,003
Women following recommendations in improving care, renovation, and remodeling of clothing.	100	9,622	644	53,809	2	366	744	63,431
Home management:								
Adult result demonstrations	125	17,415	775	90,906			900	108,321
Junior projects completed ²	59	2,120	560	35,251			619	37,371
Homes in which home accounts were kept.	39	822	269	16,327	14	323	322	17,472
Homes in which expenditures were budgeted in relation to income.	25	1,433	386	12,339	4	29	493	13,801
		586	265	6,700	3	31	293	7,317

Homes in which recommended methods in buying for the home were followed.....									
Women following recommended schedule for home activities.....	32	7,183	310	26,026	1	51	343	33,260	
Kitchens rearranged for convenience.....	84	4,684	789	25,612	3	25	876	23,554	
Homes in which—								30,331	
Labor-saving equipment was obtained.....	87	6,610	758	34,257	3	29	848	40,896	
Laundering methods were adopted.....	34	1,605	331	12,760	5	246	370	14,614	
Recommended methods in care of the house were adopted.....	66	14,362	475	42,514	4	333	545	57,209	
Assistance was given in an analysis of home conditions with reference to a standard of living.....	28	9,776	303	29,453	1	15	332	39,244	
Assistance was given in making adjustments in home making to gain a more satisfactory standard of living.....	52	15,689	404	54,009	1	6	457	69,704	
House furnishings:									
Adult result demonstrations.....	42	2,099	678	44,997	2	224	722	47,320	
Junior projects completed ¹	178	3,948	723	44,012	90	1,611	991	49,371	
Women improving—									
The selection of household furnishings.....	110	27,288	763	72,418	2	205	875	99,911	
Methods of repairing, remodeling, or refinishing of furniture.....	96	8,668	797	53,550	1	3	894	62,221	
Treatment of windows.....	85	8,461	782	44,991	2	205	869	53,657	
Arrangement of rooms.....	90	18,400	766	57,758	3	217	859	76,375	
Treatment of walls, woodwork, and floors.....	92	12,114	781	46,003	2	21	875	58,138	
Home health and sanitation:									
Adult result demonstrations.....	30	568	296	24,295	1	1	327	24,864	
Junior projects completed ¹	78	4,113	401	54,618	49	9,079	528	67,810	
Club members not in special health clubs who participated in health-improvement work.....	119	18,256	421	56,773	58	12,457	598	87,486	
Individuals following recommendations as to complete health examination.....	80	6,306	475	57,604	37	3,635	592	67,545	
Individuals improving health habits.....	104	10,617	638	107,347	47	7,001	789	124,965	
Individuals adopting positive preventive measures to improve health.....	65	3,498	549	59,781	49	5,708	663	68,987	
Homes in which better home-nursing procedure was adopted.....	50	25,496	397	136,578	12	868	459	162,942	
Homes where sanitary closets or outhouses were installed.....	34	3,246	288	16,690	1	1	323	19,946	
Homes screened.....	44	3,423	364	9,769			408	10,197	
Homes in which other methods were followed for control of flies, mosquitoes, and other insects.....	40	1,043	411	16,617	1	4	452	17,664	
Bees:	55	2,766	374	29,661			429	32,427	
Adult result demonstrations.....	210	1,334	15	170			225	1,504	
Junior projects completed ¹	117	384	14	112	23	92	154	788	
Weeds:									
Adult result demonstrations.....	496	8,887	12	1,059	1	4	509	9,950	
Junior projects completed ¹	6	49	9	1,573	4	242	19	1,864	
Handicraft:									
Adult result demonstrations.....	19	367	254	20,398			273	20,765	
Junior projects completed ¹	84	3,834	217	20,046	60	4,523	361	28,403	
Miscellaneous:									
Adult result demonstrations.....	97	1,497	87	10,105			184	11,602	
Junior projects completed ¹	96	1,319	79	8,313	58	1,928	233	11,560	
Community activities:									
Communities surveyed or scored.....	248	3,010	341	4,388	4	56	593	7,454	
Clubhouses, permanent camps, etc., built.....	122	185	134	251	5	5	261	7,441	

See footnotes at end of table.

TABLE 9.—*Results of cooperative extension work, 1930—Continued*

Project or line of work	Reported by county agricultural agents		Reported by home demonstration agents		Reported by club agents ¹		Total of all lines of work	
	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number	Agents reporting	Number
Community activities—Continued.								
Community rest rooms established.....	30	40	75	124	—	—	105	164
Community or county-wide pageants or plays presented.....	297	1,606	445	2,624	23	154	765	4,384
Communities developed in improving recreation.....	339	2,894	530	5,598	12	185	881	8,677
Communities assisted in improving hygienic practices.....	178	1,465	400	4,681	5	72	583	6,218
School or other community grounds landscaped.....	386	1,299	487	2,235	8	18	881	3,552
4-H clubs engaging in community activities.....	540	4,187	479	3,871	52	585	1,071	8,643
Different communities assisted in community work.....	688	6,781	701	9,259	40	484	1,429	16,494
Total:								
Adult result demonstrations.....	—	489,591	—	443,766	—	—	—	934,182
Junior projects completed ²	—	314,260	—	538,757	—	—	—	971,308

¹ Includes club work in counties without extension agents, reported by State club leaders.² Per cent.³ Boys' and girls' club members.⁴ Pounds.⁵ Dollars.

TABLE 10.—*Extension work with boys and girls, as reported by all county extension agents, 1930*

Junior clubs.....	56,180
Different boys enrolled.....	333,197
Different girls enrolled.....	489,517
Total enrollment.....	822,714
Different boys completing.....	222,472
Different girls completing.....	331,873
Total completing.....	554,345

BY PROJECTS ¹

Project	Boys enrolled	Girls enrolled	Boys completing	Girls completing	Units involved in club work	Quantity produced
<i>Acres</i>						
Corn.....	47,042	1,250	30,652	799	52,019	1,542,885 bushels.
Wheat.....	720	17	494	15	4,789	50,045 bushels.
Oats.....	733	24	496	22	2,110	43,426 bushels.
Rye.....	60	—	33	—	41	675 bushels.
Barley.....	188	1	144	—	643	9,819 bushels.
Other cereals.....	3,945	351	2,517	208	5,488	105,932 bushels.
Alfalfa.....	614	78	514	71	1,223	651 bushels.
Sweetclover.....	51	2	33	1	110	1,177 tons.
Other clovers.....	48	—	15	—	63	65 tons.
Vetch.....	655	23	494	22	505	46 tons.
Lespedeza.....	80	—	61	—	121	72,426 bushels.
Pastures.....	481	4	234	3	579	67 tons.
Soybeans.....	1,428	126	1,133	92	1,830	75 bushels.
Cowpeas.....	1,253	83	982	56	1,264	16 tons.
Velvetbeans.....	62	15	31	10	68	1,060 tons.
Field beans.....	745	66	604	47	696	567 bushels.
Peanuts.....	5,195	279	3,049	154	2,680	115 tons.
Other legumes.....	436	5	292	4	298	15,331 bushels.
Potatoes.....	16,193	1,441	11,811	961	5,336	56,110 bushels.
Sweetpotatoes.....	4,994	350	3,105	193	2,257	1,563 bushels.
Cotton.....	36,753	1,652	22,412	938	30,055	332 tons.
Tobacco.....	6,703	642	4,180	348	3,726	617,037 bushels.
Other special crops.....	1,453	168	960	102	1,166	207,594 bushels.
Home gardens.....	27,270	98,562	17,543	56,125	22,298	21,569,954 pounds.
Market-gardening, truck, and canning crops.....	3,479	10,885	2,251	6,882	3,490	1,710,410 pounds.
Beautification of home grounds.....	3,753	59,099	2,242	32,280	—	—
Tree fruits.....	947	2,741	574	1,933	1,728	—
Bush and small fruits.....	890	3,324	681	2,286	782	—
Grapes.....	170	1,464	116	838	180	—
Forestry.....	6,826	2,068	4,248	1,131	11,297	—
Rural engineering.....	6,879	3,720	4,411	2,290	—	—
<i>Birds</i>						
Poultry.....	46,480	54,586	28,916	32,603	2,272,741	—
<i>Animals</i>						
Dairy cattle.....	42,015	6,932	31,422	5,132	50,507	—
Beef cattle.....	14,807	1,833	11,215	1,564	15,341	—
Sheep.....	9,447	1,736	7,019	1,373	28,775	—
Swine.....	51,101	3,788	33,423	2,656	78,750	—
Horses and mules.....	799	43	512	28	769	—
Farm management.....	9,646	2,384	5,265	1,183	—	—
Food preparation.....	4,798	170,566	3,497	107,340	—	—
<i>Jars</i>						
Food preservation.....	938	142,852	445	81,960	3,504,411	—
Child training and care.....	613	7,894	392	4,116	—	—
Clothing.....	1,196	301,354	782	208,874	—	—
Home management.....	598	29,259	453	17,019	—	—
House furnishings.....	729	91,247	418	49,153	—	—
Home health and sanitation.....	9,940	97,787	6,326	61,484	—	—
Beekeeping.....	1,095	212	644	144	—	—
Weeds.....	239	1,974	208	1,656	—	—
Handicraft.....	11,230	30,478	7,900	20,503	—	—
Miscellaneous.....	3,670	12,867	2,583	8,977	—	—
Total.....	389,387	1,146,232	257,732	713,576	—	—

¹ One club member may engage in two or more projects. The sum of the projects is therefore greater than the number of different clubs and club members involved.

TABLE 11.—*Farmers' institutes conducted by extension divisions of colleges of agriculture, year ended June 30, 1930, and totals, 1926-1929*

State	Institutes	Days conducted	Sessions	Attendance	Different persons who gave lectures					State appropriation used	Other funds used
					From extension staff	From experiment station staff	From State department of agriculture staff	From special force employed for institutes	Total number of lecturers		
	Number	Number	Number	Number	Number	Number	Number	Number	Number		
Georgia.....	20	20	40	2,291	4	—	—	4	8	\$394.82	—
Indiana.....	437	569	1,138	162,920	5	7	—	41	53	13,704.85	\$19,465.07
New York.....	82	82	175	5,540	5	—	—	11	18	3,856.87	—
Ohio.....	745	1,392	3,584	693,561	2	2	—	83	87	22,215.00	15,400.00
South Dakota.....	31	51	117	13,774	11	1	—	4	16	1,004.60	792.06
Wisconsin.....	690	754	1,547	119,059	30	5	9	33	77	30,000.00	—
Total, 1930.....	2,005	2,863	6,601	997,145	59	15	9	176	259	71,156.14	35,657.13
1929.....	2,118	2,933	6,410	1,021,292	85	23	15	192	315	70,739.62	37,618.83
1928.....	1,972	2,971	6,872	1,095,436	117	34	8	180	339	73,542.07	37,836.52
1927.....	1,985	2,880	6,603	962,211	104	12	8	184	308	59,645.74	28,452.53
1926.....	2,130	2,934	6,556	969,864	93	15	3	215	326	63,022.83	25,139.60

TABLE 12.—*Farmers' institutes conducted by State departments of agriculture, year ended June 30, 1930, and totals, 1926-1929*

State	Institutes	Days conducted	Sessions	Attendance	Different persons who gave lectures					State appropriation used	Other funds used
					From extension staff	From experiment station staff	From State department of agriculture staff	From special force employed for institutes	Total number of lecturers		
	Number	Number	Number	Number	Number	Number	Number	Number	Number		
Illinois.....	215	301	902	104,370	—	35	—	7	¹ 184	\$30,489.19	\$4,825.00
Iowa.....	89	308	756	139,904	—	—	—	—	² 194	7,771.54	23,109.79
Maine.....	275	275	310	28,000	—	—	—	4	³ 16	3,000.00	—
Total, 1930.....	579	884	1,968	272,274	—	35	2	11	² 394	41,260.73	27,934.79
1929.....	482	1,008	2,619	245,192	—	37	12	147	³ 414	36,659.65	22,613.86
1928.....	573	849	2,154	258,407	119	40	20	241	420	39,993.96	24,429.59
1927.....	275	545	1,415	201,034	3	37	5	129	³ 454	68,032.53	14,000.00
1926.....	119	1,061	2,256	192,756	—	37	12	172	³ 464	70,021.46	31,452.96

¹ Includes 7 from State departments other than agriculture and farmers' institutes and also 133 from sources other than those mentioned.

² No records were kept other than the total, but the statement was made that the extension, college, and experiment station staffs together furnished more than half the number of lecturers reported.

³ Includes lecturers from sources other than those mentioned.

TABLE 13.—Number of counties with women county extension agents (white, home demonstration work) on July 1, 1914–1930

APPENDIX

99

State	Num- ber of count- ies	Counties having agents on July 1—													1929	1930
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Alabama.....	67	18	19	27	28	67	54	32	36	34	34	35	37	38	38	39
Arizona.....	14	15	20	31	47	65	58	42	34	10	9	11	9	8	9	18
Arkansas.....	75	20	31	47	47	65	58	42	34	10	9	11	39	35	46	56
California.....	58	20	31	47	47	65	58	42	34	10	9	11	39	35	46	56
Colorado.....	63	2	2	2	5	24	3	2	1	16	21	23	22	23	26	25
Connecticut.....	8	2	2	2	5	24	3	2	1	16	21	23	22	23	26	25
Delaware.....	3	2	2	2	5	24	3	2	1	16	21	23	22	23	26	25
Florida.....	67	24	27	28	35	125	93	29	28	29	24	31	30	32	30	28
Georgia.....	161	29	48	45	57	125	93	66	66	70	68	64	61	61	58	70
Idaho.....	4	5	5	5	5	21	5	5	5	21	30	30	27	18	10	143
Illinois.....	102	1	1	1	1	24	17	11	11	11	16	21	21	22	22	20
Indiana.....	92	22	22	22	22	88	88	5	3	2	2	1	1	1	1	1
Iowa.....	99	22	22	22	22	96	23	19	21	18	17	13	15	12	14	12
Kansas.....	105	19	19	24	27	14	8	9	7	8	9	10	15	17	16	23
Kentucky.....	120	9	13	18	20	96	74	18	19	26	24	24	24	25	21	20
Louisiana.....	64	13	13	18	20	33	32	24	25	26	28	28	24	25	25	38
Maine.....	16	1	1	1	1	14	2	5	10	14	15	15	15	15	15	15
Maryland.....	23	5	6	10	13	22	23	21	17	16	17	18	19	19	18	20
Massachusetts.....	14	1	1	1	1	12	10	9	9	11	9	10	11	11	11	11
Michigan.....	83	1	1	1	1	24	13	12	10	8	7	7	5	5	6	6
Minnesota.....	87	1	1	1	1	39	14	8	7	4	3	8	8	8	6	4
Mississippi.....	82	33	33	32	49	71	64	53	35	48	51	45	44	43	47	50
Missouri.....	114	33	33	32	49	48	20	11	14	13	8	11	9	9	7	12
Montana.....	56	11	11	11	11	18	11	9	7	11	7	5	6	6	7	12
Nebraska.....	93	10	10	10	10	30	10	7	7	3	3	2	2	1	1	10
Nevada.....	17	1	1	1	1	10	5	5	6	4	4	4	4	9	6	8
New Hampshire.....	10	1	1	1	1	9	6	6	6	6	8	7	8	8	9	10
New Jersey.....	21	1	1	1	1	8	5	3	5	9	8	12	11	12	12	13
New Mexico.....	31	1	1	1	1	11	5	4	4	2	2	4	5	4	5	4
New York.....	62	34	44	48	48	38	24	22	28	31	32	35	38	37	34	35
North Carolina.....	100	27	34	44	48	72	66	59	47	49	50	48	49	49	49	49
North Dakota.....	53	1	1	1	1	33	5	4	4	6	2	2	2	1	1	1
Ohio.....	88	19	24	22	23	13	50	2	7	10	8	11	15	15	16	19
Oklahoma.....	77	19	24	22	23	15	46	40	33	37	42	50	44	47	49	50
Oregon.....	36	1	1	1	1	15	5	5	6	4	4	3	3	3	2	3
Pennsylvania.....	67	1	1	1	1	48	15	5	6	4	28	28	28	54	63	165
Rhode Island.....	5	21	24	31	36	4	45	2	3	5	2	2	2	2	2	15
South Carolina.....	46	21	24	31	36	44	45	45	36	36	36	38	38	34	36	35
South Dakota.....	69	18	24	31	40	42	3	3	3	1	1	15	19	32	37	147
Tennessee.....	77	18	24	31	40	94	77	41	26	25	28	27	26	27	27	34
Texas.....	95	26	27	38	31	67	69	55	38	52	79	91	88	90	88	89
Texas.....	254	26	27	38	31	67	69	55	38	52	79	91	88	90	88	89

1 Some agents cover two or more counties.

TABLE 13.—*Number of counties with women county extension agents (white, home demonstration work) on July 1, 1914-1930—Continued*

State		Num- ber of count- ties	Counties having agents on July 1—																
			1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Utah.....	29			2	2	14	4	6	3	15	4	5	11	9	8	16	19	10	
Vermont.....	14					7	5	4	6	9	10	9	7	5	5	8	11	11	
Virginia.....	100	17	22	25	38	52	36	28	23	30	34	36	35	34	34	33	36	40	
Washington.....	39					22	6	8	7	7	6	5	5	5	5	6	11	11	
West Virginia.....	55	5	10	12	12	33	22	12	8	18	15	23	15	17	17	18	28	26	
Wisconsin.....	71					17	4	2	1	1	1	1	1	1	1	1	4	4	
Wyoming.....	23					5	7	7	6	6	6	6	5	5	6	6	9	8	
Hawaii.....	5																3	4	
Total.....	3, 077	279	350	430	537	1, 715	1, 049	784	699	801	874	930	929	946	950	1, 041	1, 286	1, 333	

1 Some agents cover two or more counties.

TABLE 14. — *Number of counties with men county extension agents (white) on July 1, 1914–1930*

State	Num- ber of count- ies	Counties having agents on July 1—													1929	1930
		1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928
Alabama.....	67	67	67	65	62	66	65	55	55	55	54	59	59	57	56	61
Arizona.....	14	14	3	6	7	11	11	10	9	11	11	10	12	12	12	12
Arkansas.....	75	45	52	53	61	68	66	58	44	40	47	45	50	48	63	64
California.....	58	4	11	13	17	33	35	35	37	40	41	40	43	41	41	39
Colorado.....	63	13	13	19	16	29	27	24	24	26	23	28	20	22	24	27
Connecticut.....	8	1	6	7	8	8	8	8	8	8	7	8	8	8	8	8
Delaware.....	3	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3
Florida.....	67	25	36	33	37	53	47	32	31	33	37	33	36	41	45	47
Georgia.....	161	80	81	83	117	120	134	97	85	98	88	89	121	90	95	101
Idaho.....	44	2	3	7	11	27	32	34	32	28	21	19	16	18	23	24
Illinois.....	102	14	18	20	22	53	63	81	85	85	94	95	95	95	96	94
Indiana.....	92	27	31	32	40	83	76	68	82	85	86	82	79	82	81	85
Iowa.....	99	9	11	16	26	97	99	99	99	99	99	98	99	97	98	98
Kansas.....	105	9	39	56	53	67	53	51	59	56	58	57	63	64	64	66
Kentucky.....	120	28	39	47	45	90	71	53	61	61	59	67	72	71	70	86
Louisiana.....	64	41	43	43	42	58	55	41	38	45	45	46	48	51	52	56
Maine.....	16	8	3	4	9	16	16	16	16	16	22	23	23	16	16	16
Maryland.....	23	13	13	16	23	22	23	22	23	22	23	23	23	23	23	22
Massachusetts.....	14	1	10	9	11	13	13	11	11	11	11	12	11	11	11	11
Michigan.....	83	11	17	23	30	71	63	60	64	69	64	57	57	54	53	55
Minnesota.....	87	27	23	19	16	85	86	83	83	77	67	62	58	61	60	62
Mississippi.....	82	48	49	44	53	79	75	71	50	56	56	56	53	56	60	63
Missouri.....	114	13	15	14	15	71	52	47	58	55	54	23	50	69	77	77
Montana.....	56	4	8	7	12	23	24	27	26	26	24	23	23	26	65	74
Nebraska.....	93	5	8	9	8	79	54	39	46	42	42	41	43	39	39	30
Nevada.....	17	1	5	8	6	8	4	6	7	9	11	11	8	8	9	11
New Hampshire.....	10	1	5	8	9	10	10	9	10	10	10	10	10	10	10	10
New Jersey.....	21	4	7	11	10	17	18	18	18	18	18	19	18	18	19	19
New Mexico.....	31	1	8	9	11	25	26	22	19	18	22	20	21	19	20	21
New York.....	62	25	29	36	41	56	55	55	55	55	55	56	55	55	55	55
North Carolina.....	100	51	64	65	69	91	87	77	59	66	73	76	74	74	78	80
North Dakota.....	53	17	15	15	17	38	32	28	36	36	33	34	33	33	33	31
Ohio.....	88	8	10	12	20	63	65	63	80	83	85	81	85	83	80	78
Oklahoma.....	77	40	56	59	62	77	70	73	71	74	67	61	65	68	69	70
Oregon.....	36	10	12	13	14	24	23	26	26	24	22	21	28	28	27	28
Pennsylvania.....	67	10	14	22	45	53	40	54	57	63	60	63	63	64	65	65
Rhode Island.....	5	4	4	4	4	5	4	4	4	4	4	4	5	5	3	4
Rhode Island.....	46	43	43	42	40	43	45	45	42	42	38	39	40	39	39	40
South Carolina.....	69	3	5	11	13	59	36	39	43	48	43	36	34	35	34	33
South Dakota.....	36	36	38	48	57	91	70	45	38	41	48	54	50	53	58	61
Tennessee.....	95	36	38	48	57	91	70	45	38	41	48	54	50	53	58	61

1 Some agents cover two or more counties.

FUNDS, 1930

Expenditures of Federal funds and funds from sources within the States and Territories for cooperative extension work during the fiscal year ended June 30, 1930, amounted to \$24,706,761.64, which exceeded the amount expended for the work in 1929 by \$1,420,112.87. Of the additional funds expended, \$344,701.15 came from Federal sources, principally the increase of \$500,000 in Capper-Ketcham funds. The increased Federal funds were offset in part by a reduction in emergency funds available for employing agents in counties in the flood-devastated regions; \$638,624.48 was from State and college sources; and \$436,787.24 from county appropriations, local organizations, and individuals. Of the total amount, \$24,266,064.87, or 98.2 per cent, was spent in the 48 States and the Territories of Hawaii and Porto Rico, and \$440,696.77, or 1.8 per cent, in the administrative activities of the Federal office in Washington, D. C. Of the total funds, \$9,173,413.46, or approximately 37.1 per cent, was from Federal sources; \$7,172,266.60, or 29 per cent, from State and college sources; \$7,099,140.59, or 28.8 per cent, from county appropriations; and \$1,261,940.99, or 5.1 per cent, from local organizations and individuals.

The amount expended for county extension agents was \$15,317,609, or 62 per cent; for State subject-matter specialists, \$4,738,798, or 19.2 per cent; for administration and supervision in the States and Territories, \$4,209,658, or 17 per cent.

Ten States and the Territory of Hawaii were unable to expend their entire allotments of Federal Smith-Lever and Capper-Ketcham funds and had unexpended balances on June 30, 1930, as shown in Table 15.

TABLE 15.—*Unexpended balances of Federal Smith-Lever and Capper-Ketcham funds, June 30, 1930*

State	Unexpended balances		State	Unexpended balances	
	Federal Smith-Lever	Federal Capper-Ketcham		Federal Smith-Lever	Federal Capper-Ketcham
Colorado.....	\$5.00	-----	Oregon.....	-----	\$6.10
Hawaii.....	-----	\$977.73	Pennsylvania.....	-----	11,270.27
Idaho.....	-----	.10	Rhode Island.....	\$703.17	2,303.99
Minnesota.....	-----	85.05	Washington.....	-----	4,831.15
Montana.....	-----	451.56			
New York.....	178.65	41.79	Total.....	886.82	21,258.39
Ohio.....	-----	1,290.65			

Two States expended more than 20 per cent of their Federal Capper-Ketcham funds for purposes other than salaries of county extension agents and refunded the excess amounts to the Federal Treasury, Louisiana refunding \$60.36 and Oregon refunding \$1.22.

The Legislature of Alabama, on February 5, 1931, assented to the provisions and requirements of the Capper-Ketcham Act of May 22, 1928.

Of the Federal Capper-Ketcham funds expended during the year, approximately 88.6 per cent was for salaries of county extension agents, and about 50 per cent was for women extension workers.

Statements of the funds expended in each State and in the Territories of Hawaii and Porto Rico by items of expense, lines of work, and sources, are given in Tables 16 to 27.

TABLE 16.—Expenditures from the United States appropriation of May 8, 1914 (Federal Smith-Lever) for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by items of expense, and totals for 1915-1929

State	Total appropriation	Personal services—salaries and labor	Printing, binding, and cuts for publications	Supplies and materials	Communication service	Transportation of things	Heat, light, and power	Equipment	Travel expenses	Miscellaneous	Unexpended balance
Alabama	\$213,041.91	\$182,957.03	\$1,342.70	\$2,371.06	\$1,920.76	\$113.28		\$1,846.67	\$22,204.64	\$285.77	
Arizona	33,920.44	29,382.19	1,340.71	368.32	176.79	20.07		246.04	2,386.52		
Arkansas	171,397.98	112,621.30	7,508.76	7,308.68	1,974.75	315.39		4,175.96	34,778.08	2,715.06	
California	130,921.71	104,278.95	5,392.44	5,392.44	1,627.78	8.53		752.62	19,691.27	635.12	
Colorado	68,703.73	49,174.15	1,870.13	2,577.76	1,242.59	184.51		635.05	7,003.37	11.17	\$5.00
Connecticut	59,057.38	59,057.38									
Delaware	21,288.65	13,545.34	1,370.54	1,717.69	775.02	23.34		\$14.65	2,993.08	48.99	
Florida	77,646.71	77,646.71									
Georgia	249,382.01	249,381.51			50						
Idaho	44,341.76	33,972.08	495.55	750.34	220.52	15.02		39.90	9,039.35		
Illinois	239,624.84	193,745.95	6,915.60	8,364.55	2,234.67	130.52		3,539.49	24,142.32	531.24	
Indiana	169,833.14	144,070.45	1,260.45	3,304.94	400.00	.59		779.26	19,983.70	333.75	
Iowa	178,775.89	175,695.15							3,080.74		
Kansas	137,122.84	131,263.85	439.95	2,762.97	14.26			1,211.97	1,990.39	40.15	
Kentucky	206,885.86	74,096.76	5,197.30	6,491.81	1,716.07	323.47	\$8,600.00	1,344.01	112,801.93	252.51	
Louisiana	139,226.80	136,134.45	1,188.32	1,066.30	38.24	10.00		1,490.13	298.73		
Maine	61,724.30	46,694.93	1,280.10	710.91	595.39	16.61		1,433.38	10,939.68	12.27	
Maryland	74,068.49	65,806.45	785.55	434.10	137.14	21.09	62.75		6,800.06	21.35	
Massachusetts	32,316.26	31,842.43			1.75				472.08		
Michigan	167,549.32	167,549.32									
Minnesota	157,466.02	136,604.06		15.36	140.96	3.83			20,701.81		
Mississippi	181,201.86	155,685.16	2,557.92		180.79				22,056.99	741.00	
Missouri	210,645.26	168,285.51	5,662.26	3,382.11	540.20	128.44		1,775.13	30,772.51	99.10	
Montana	51,613.89	49,840.18	1,000.00		5.81	1.23			766.67		
Nebraska	108,389.25	108,194.20	1,230.05					75.00			
Nevada	16,862.72	12,468.65	383.66	978.90	830.56	49.02		328.67	1,562.51	60.75	
New Hampshire	28,033.64	26,724.33	121.22	33.08	21	300.00	700.00	21.00	133.80		
New Jersey	84,378.43	47,412.23	2,175.48	8,165.72	1,306.62	72.50	742.51	3,914.35	20,098.72	490.30	
New Mexico	42,616.21	33,612.18	8.99	237.89	91.19	20.67			8,433.51	20.92	
New York	208,241.56	165,964.72	5,442.63	3,747.75	1,451.16	108.01		1,676.07	29,604.47	168.09	178.65
North Carolina	238,426.37	238,426.37									
North Dakota	71,083.80	48,179.62	670.12	3,425.56	444.59	167.58		792.87	17,973.37	29.08	
Ohio	239,917.62	183,545.30	11,716.80	4,913.53	3,419.54	435.97		2,348.59	33,127.19	210.70	
Oklahoma	174,280.77	127,149.33	2,671.54	6,842.43	3,364.04	87.32		619.11	33,930.84	25.30	
Oregon	53,324.53	35,617.74	307.31	2,440.26	1,213.76	17.05		257.29	12,766.34	104.60	
Pennsylvania	353,641.38	284,066.44	723.67	5,677.78	1,623.14	161.23		86.81	63,490.55	809.76	
Rhode Island	11,080.24	5,594.44	273.50	1,247.89	46.08	1.40		933.83	2,854.32	25.61	703.17
South Carolina	163,431.23	104,317.99	5,875.17	8,903.34	4,724.83	138.59	621.28	912.83	36,409.25	1,547.95	
South Dakota	69,037.45	68,902.25							135.20		
Tennessee	200,652.31	172,274.00	8,268.25	4,525.50	913.58	165.82	923.55	1,641.85	11,482.26	468.50	
Texas	357,574.42	295,309.15	4,466.52	6,250.30	2,660.26	286.84		1,626.92	47,157.36	117.07	

	Utah.....	35,816.87	32,453.58	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82
Vermont.....	29,833.77	29,833.77	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
Virginia.....	174,715.21	174,715.21	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
Washington.....	190,554.95	190,554.95	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
West Virginia.....	77,121.21	77,121.21	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
Wisconsin.....	130,873.37	130,873.37	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
Wyoming.....	163,204.06	163,204.06	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
Hawaii.....	25,133.15	25,133.15	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
Total, 1930.....	27,905.20	27,905.20	175.08	118,743.30	37,930.98	4,168.84	6,749.55	38,443.78	709,099.97	10,285.94	886.82	
1929.....	6,172,180.80	6,172,180.80	106,232.06	127,660.85	45,542.41	5,886.00	9,200.78	47,871.48	893,319.92	10,558.16	12,403.32	
1928.....	5,880,000.00	4,747,854.16	79,362.27	110,867.79	40,951.79	4,982.42	9,629.45	31,777.20	841,785.79	11,584.14	1,204.99	
1927.....	5,880,000.00	4,708,815.40	81,653.50	118,545.59	49,676.60	6,275.75	10,420.66	37,492.64	854,264.87	11,291.73	1,563.26	
1926.....	5,880,000.00	4,597,073.13	99,177.47	125,510.84	41,190.91	6,283.97	11,071.82	39,043.21	927,124.07	10,935.48	22,581.10	
1925.....	5,879,999.99	4,660,134.68	91,840.89	109,079.77	35,844.39	5,662.97	8,433.13	40,018.71	918,174.14	11,845.01	916.10	
1924.....	5,880,000.00	4,583,765.05	86,132.30	106,380.09	40,964.27	5,463.23	8,945.15	38,726.37	983,709.01	5,479.55	20,394.99	
1923.....	5,880,000.00	4,447,492.44	113,901.41	130,023.94	40,240.02	1,609.05	9,009.22	47,247.12	1,019,854.81	6,944.88	59,183.11	
1922.....	5,580,000.00	4,265,041.66	107,237.37	106,177.73	40,165.09	---	7,914.66	40,701.62	935,937.26	7,174.06	69,650.55	
1921.....	5,080,000.00	3,727,417.45	96,897.63	115,770.50	47,829.09	---	6,269.91	50,585.69	920,621.97	8,656.26	105,951.50	
1920.....	4,580,000.00	3,210,273.50	113,311.71	127,097.40	42,254.14	---	4,614.66	48,695.97	911,947.11	6,149.87	115,655.64	
1919.....	2,580,000.00	1,660,720.95	105,120.93	134,166.83	43,054.00	---	2,618.28	91,655.52	496,439.74	5,061.79	41,171.96	
1918.....	2,580,000.00	1,381,547.05	76,910.28	109,656.02	39,627.12	---	2,412.57	61,433.27	394,481.91	1,998.07	11,933.71	
1917.....	1,580,000.00	1,140,061.93	43,927.84	52,587.62	20,041.81	---	1,338.98	36,881.97	278,867.24	1,346.99	4,945.62	
1916.....	1,080,000.00	756,165.64	27,867.77	40,863.34	12,154.06	---	968.63	39,404.50	201,084.45	1,415.34	2,076.27	
1915.....	480,000.00	329,143.14	8,241.16	15,463.39	5,539.85	---	146.85	19,769.52	96,402.41	228.41	5,065.27	

¹ Prior to 1923, transportation of things was included in communication service.

State	Total appropriation	Personal services—salaries and labor	Printing, binding, and curs for publications	Supplies and materials	Communication service	Transportation of things	Heat, light, water, and power	Equipment	Travel expenses	Miscellaneous	Unexpended balance
Alabama	\$203,041.91	\$155,626.91	\$6,982.99	\$5,938.50	\$2,163.86	\$643.76		\$5,593.40	\$25,919.02	\$173.47	
Arizona	23,920.44	17,233.12	206.52	1,287.59	292.40	4.37		61.50	4,834.94		
Arkansas	161,397.98	155,609.39		1,923.99	661.57			1,333.53		1,963.50	
California	120,921.71	120,921.71									
Colorado	53,703.73	46,042.78	965.09	1,446.73	461.30	32.64		226.64	4,523.55		\$5.00
Connecticut	49,667.38	31,202.63		757.86					17,007.04		
Delaware	11,288.65	5,283.65							6,000.00		
Florida	67,646.71	32,704.29	5,209.19	3,402.51	435.97	10.04		1,004.82	24,785.54	34.35	
Georgia	239,382.01	181,335.41	5,002.99	6,212.14	3,123.23	99.54	\$1,650.00	2,622.48	39,335.72	30.00	
Idaho	34,541.76	26,330.23	300.00	903.17	611.38	10.87			6,356.11		
Illinois	229,624.34	229,624.34									
Indiana	159,833.14	159,833.14									
Iowa	168,775.89	168,775.89									
Kansas	127,122.84	94,187.83							32,935.01		
Kentucky	196,883.86	196,883.86									
Louisiana	129,226.59	85,749.32	2,683.94	5,508.92	1,282.96	295.87	7.01	2,875.34	30,076.85	741.38	
Maine	51,724.50	26,305.69	44.12	2,215.64	605.24	85.13		565.11	21,842.10	61.47	
Maryland	64,068.49	51,636.10	1,366.42	1,623.65	654.46	956.68		373.98	7,330.70	96.50	
Massachusetts	22,316.26	22,316.26									
Michigan	157,549.32	157,549.32									
Minnesota	147,466.02	140,244.23									
Mississippi	171,201.86	154,417.49									
Missouri	200,643.26	172,057.09									
Montana	41,613.89	40,377.30									
Nebraska	98,349.25	67,960.46	300.85	6,978.24	1,830.38	300.07		4,497.00	16,089.23	373.01	
Nevada	6,862.72	4,989.60		208.93	15.76	3.42		55.90	1,588.61	.50	
New Hampshire	18,033.64	18,033.64									
New Jersey	74,378.43	74,255.02									
New Mexico	32,616.21	18,875.02	2,099.87	2,782.82	850.34	336.22	600.00	1,806.61	5,223.91	41.42	178.65
New York	198,241.56	198,062.91									
North Carolina	228,426.37	140,544.49	5,249.93	4,683.28	1,910.02	269.00	1,511.00	861.75	73,290.48	106.42	
North Dakota	61,683.39	58,727.75	336.29	99.11	3.66		2,000.00		516.58		
Ohio	229,917.62	205,765.67							24,151.95		
Oklahoma	164,389.77	163,675.75		208.12				505.90			
Oregon	43,324.53	43,324.53									
Pennsylvania	343,641.38	226,034.31	420.34	5,718.61	8,497.01	104.05	1,687.51	344.71	91,811.25	9,023.59	703.17
Rhode Island	640.24	530.75		153.04	148.88	46.12		98.28			
South Carolina	153,451.23	153,451.23									
South Dakota	59,027.45	26,574.88	2,233.11	5,395.16	1,147.30	216.16		1,153.90	22,107.38	210.06	
Tennessee	190,653.31	151,261.98	2,292.28	7,492.76	1,504.37	305.92	13.38	794.80	26,011.76	976.06	
Texas	347,874.42	335,731.38	910.84						11,232.00		

TABLE 17.—Expenditures from the United States appropriation of May 8, 1914 (State Smith-Lever) for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by items of expense, and totals for 1916–1929

Utah.....	25,816.87	23,913.10	465.67	107.66	22.69	360.00	95.50	1,229.04	15,021.93	886.82
Vermont.....	26,770.93	22,710.05	190.22	201.83	26.19	---	82.04	3,194.50	14,942.83	12,403.32
Virginia.....	180,554.95	106,332.94	2,463.25	749.68	26.19	---	---	65,390.25	8,034.92	1,204.99
Washington.....	67,121.21	59,659.26	1,405.94	175.28	30.13	---	11.66	3,916.44	8,089.82	1,563.26
West Virginia.....	120,873.37	115,181.63	---	11.30	---	---	---	3,680.44	7,465.67	816.90
Wisconsin.....	153,204.06	108,950.93	3,466.20	3,634.95	---	---	43.90	36,171.71	7,413.94	916.10
Wyoming.....	15,133.15	15,000.01	125.40	---	---	---	7.74	---	11,220.40	20,394.99
Hawaii.....	17,905.20	11,370.32	633.70	98.39	18.17	---	995.30	---	5,272.14	59,183.11
Total, 1930.....	5,692,936.00	4,823,075.34	82,526.57	34,414.48	4,030.92	8,496.85	28,335.11	644,544.04	15,021.93	69,650.55
1929.....	5,682,180.80	4,898,233.62	62,093.91	27,083.32	3,803.62	5,770.91	32,000.99	579,788.78	14,942.83	115,685.64
1928.....	5,400,000.00	4,709,353.48	42,744.30	26,028.16	2,331.92	5,237.79	18,891.78	545,679.20	8,034.92	41,171.96
1927.....	5,400,000.00	4,700,633.63	44,348.94	26,237.92	2,412.33	4,628.74	13,385.53	540,365.54	8,089.82	11,933.71
1926.....	5,400,000.00	4,711,692.12	47,014.19	30,780.71	4,717.07	5,051.17	10,962.57	538,576.17	7,465.67	4,945.62
1925.....	5,399,999.99	4,664,630.42	51,852.67	25,662.11	2,755.91	4,724.92	12,666.14	584,930.38	11,220.40	20,394.99
1924.....	5,400,000.00	4,637,018.08	46,053.65	29,212.57	4,409.56	6,075.61	17,207.77	568,349.42	5,272.14	59,183.11
1923.....	5,400,000.00	4,655,864.27	49,671.43	25,956.13	1 4,257.77	4,827.45	22,819.11	520,258.46	7,187.79	69,650.55
1922.....	5,100,000.00	4,254,787.62	49,834.16	27,459.91	---	5,105.09	24,684.34	587,035.78	1,393.41	105,951.50
1921.....	4,600,000.00	3,850,788.52	40,298.04	16,461.40	---	3,104.69	21,019.47	484,159.39	7,503.05	115,685.64
1920.....	4,100,000.00	3,382,628.44	46,471.18	26,754.12	---	3,357.21	18,452.15	440,221.83	6,522.71	41,171.96
1919.....	2,100,000.00	1,484,785.07	77,990.43	28,237.75	---	2,824.06	33,157.82	369,769.41	3,486.85	11,933.71
1918.....	1,600,000.00	1,189,520.31	46,437.58	20,826.08	---	3,052.65	24,613.74	259,998.19	1,884.86	4,945.62
1917.....	1,100,000.00	825,004.97	34,822.25	12,441.66	---	232.44	17,015.59	171,145.06	1,331.24	2,076.27
1916.....	600,000.00	455,471.00	21,505.74	5,397.94	---	223.28	11,738.17	87,038.02	---	---

¹ Prior to 1923, transportation of things was included in communication service.

TABLE 18.—Expenditures from United States appropriation authorized May 22, 1928 (Federal Capper-Ketcham), for cooperative agricultural extension work in each State and Hawaii for year ended June 30, 1930, by items of expense, and total for 1929

State	Total appropriation	Personal services	Publications	Supplies	Communication service	Transportation of things	Heat, light, water, and power	Equipment	Travel expenses	Miscellaneous	Unexpended balance
Alabama.....	\$37,832.70	\$35,645.70	\$593.07	\$853.72	\$24.98	\$2.82		\$47.30	\$740.30		
Arizona.....	22,100.88	20,585.86		167.75				52.05	1,263.67	\$2.50	
Arkansas.....	34,175.28	33,769.81		353.42							
California.....	30,620.32	28,003.83							2,616.49		
Colorado.....	24,716.70	23,190.48	46.50	82.11	84.36	5.39			1,302.86	5.00	
Connecticut.....	24,308.64	23,837.58			60.60			35.55	410.46		
Delaware.....	20,991.46	20,141.50		77.40	1.38				735.63		
Florida.....	25,941.28	25,407.09		221.19				313.00	930.60		
Georgia.....	41,024.48	40,093.88									
Idaho.....	23,083.74	18,717.07		96.24	124.03	1.77		6.50	4,088.03		\$0.10
Illinois.....	40,167.48	36,551.38		36.01	37.94	4.64			3,537.51		
Indiana.....	34,037.85	33,397.20		70.66					369.99		
Iowa.....	34,823.28	34,823.28									
Kansas.....	31,164.96	31,164.96									
Kentucky.....	37,291.95	37,291.95									
Louisiana.....	31,349.73	29,905.19	4.02	423.37	84.48	.42		264.00	607.89		60.36
Maine.....	24,542.86	19,651.51			1.42				4,891.35		
Maryland.....	25,627.02	25,177.77							447.83		
Massachusetts.....	21,960.00	21,960.00									
Michigan.....	33,837.26	33,837.26		88.24		65.08		242.65	498.37	55.00	85.05
Minnesota.....	32,951.66	31,917.27			4.50				2,316.31		
Mississippi.....	35,036.35	32,713.54		73.42	1.50				826.79		
Missouri.....	37,622.30	36,720.59	312.25	83.18	1.98	7.09		590.93	429.82		451.56
Montana.....	23,654.87	21,778.06									
Nebraska.....	28,641.35	28,641.35		33.76	.26	1.26	\$9.02	52.75	1,100.70		
Nevada.....	20,602.75	19,405.00									
New Hampshire.....	21,583.90	21,522.84	61.06								
New Jersey.....	26,592.51	26,518.44		154.25	14.07			17.35	1,661.92	1.00	41.79
New Mexico.....	37,864.62	30,973.02			54.55	2.53			15.07		
New York.....	37,411.20	37,354.34									
North Carolina.....	40,062.27	40,062.27									
North Dakota.....	25,417.54	22,427.12		10.24	36.76	.91			2,942.06	.45	1,290.65
Ohio.....	40,193.24	36,402.04	1,868.95	116.55	4.29				515.05		7.32
Oklahoma.....	34,438.05	34,433.76		28.76	19.60				112.44		11,270.27
Oregon.....	23,805.11	23,636.99									2,303.99
Pennsylvania.....	38,911.12	38,911.12									
Rhode Island.....	50,181.39	50,181.39									
South Carolina.....	33,477.33	17,579.38									
South Dakota.....	25,185.15	25,185.15									
Tennessee.....	36,744.72	36,744.72							15.81		
Texas.....	50,553.17	50,553.17									
Utah.....	20,267.45	20,721.68	483.79	559.31	.85	3.90		162.95	334.97		
Vermont.....	22,351.25	21,815.59		41.08	1.77	1.32		36.38	455.11		

Virginia.....	35,857.81	34,714.87	-----	205.04	228.30	33.23	10.64	-----	659.48	6.25	-----
Washington.....	25,895.13	20,516.55	-----	484.00	4.55	8.88	-----	50.00	-----	-----	4,831.15
West Virginia.....	30,616.08	29,528.39	-----	-----	4.44	-----	-----	-----	1,083.25	-----	-----
Wisconsin.....	33,455.63	32,425.73	-----	934.24	.60	-----	-----	-----	95.06	-----	-----
Wyoming.....	21,329.11	21,329.11	-----	-----	-----	-----	-----	-----	-----	-----	-----
Hawaii.....	21,572.53	18,641.91	-----	438.20	28.89	2.75	-----	197.00	623.46	15.75	977.73
Total, 1930.....	1,480,000.00	1,409,988.82	-----	5,632.14	826.10	141.99	19.66	2,332.61	35,636.28	85.95	21,319.97
1929.....	980,000.00	827,862.48	-----	6,016.62	1,559.87	270.05	22.24	4,018.15	45,691.60	739.21	88,982.35

Vermont.....	2,351.25	1,616.72	238.49	19	409.48	86.37	-----
Virginia.....	15,867.81	8,478.98	6.57	80.00	4,062.33	-----	-----
Washington.....	3,895.13	1,063.98	-----	-----	-----	-----	4,831.15
West Virginia.....	10,616.08	8,039.83	-----	2.88	2,573.37	-----	-----
Wisconsin.....	13,455.63	9,687.76	35.85	31.17	3,700.86	-----	-----
Wyoming.....	1,329.11	1,329.11	-----	-----	-----	-----	-----
Hawaii.....	1,572.53	500.00	31.05	-----	33.75	30.00	977.73
Total, 1930.....	500,000.00	421,354.77	2,500.48	2,646.15	47,510.53	2,910.51	19,163.55

TABLE 20.—Expenditures of funds from the United States appropriation of May 8, 1914 (Federal Smith-Lever) for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by projects, and totals for 1915-1929

State	Total	Admin- istration	Printing and distri- bution of pub- lica- tions	County agent work	Home demonstra- tion work	Boys' and girls' club work	Home economics lists 2 3	Exten- sion schools	Animal hus- bandry	Poultry	Dairying	Animal diseases	Agron- omy	Foods and nutrition	Child care and training
Alabama.....	\$213,041.91	\$10,020.42	\$1,373.70	\$89,253.60	\$43,392.75	\$5,424.18		\$4,238.18	\$4,940.72	\$4,940.73	\$4,940.73		\$3,300.00	\$3,300.00	
Arizona.....	33,920.44	1,340.71	1,114.88	6,320.94	6,320.94	1,502.18			2,307.11	1,201.58	1,728.41		1,426.56	4,334.64	
Arkansas.....	171,397.98	10,469.28	7,508.76	11,318.34	46,313.81	5,783.91		5,594.34	2,307.11	2,362.21	3,413.90		2,441.27		
California.....	130,921.71	2,634.75	1,870.13	26,660.63	49,312.98	6,706.86			2,063.20	2,707.72	2,388.46		2,506.91	2,111.56	
Colorado.....	63,703.73	3,500.55	2,000.00	26,660.63	49,312.98	6,706.86			2,063.20	2,707.72	2,388.46		2,506.91	2,111.56	
Connecticut.....	59,057.58	2,500.00	1,372.54	8,070.81	6,404.00	8,566.58		\$2,106.16		4,649.98	4,784.31		2,133.32	1,599.97	
Delaware.....	21,288.65	4,229.17		3,224.52	3,485.07									256.70	
Florida.....	77,646.71	3,800.25		120,193.81	59,561.03	8,460.00			5,025.00	3,600.00	3,600.00		9,100.00	3,200.00	
Georgia.....	249,382.01	4,500.25	495.55	15,239.07	7,523.33	510.00			5,898.78	3,731.35	3,303.18		2,623.82	2,750.00	
Idaho.....	44,541.76	5,349.47	7,355.52	79,404.73	37,328.73	14,393.90			5,898.78	3,731.35	3,303.18		2,623.82	2,750.00	
Illinois.....	239,624.34	26,588.97	1,260.45	15,239.07	7,523.33	510.00			5,898.78	3,731.35	3,303.18		2,623.82	2,750.00	
Indiana.....	169,833.14	10,280.29	1,260.45	67,499.89	12,348.00	7,905.17		3,766.71	13,115.60	9,616.59	13,335.99		9,436.94	6,086.69	
Iowa.....	178,775.89	12,083.86	1,726.07	67,088.76	26,602.07	7,705.17		1,965.98	7,200.00	5,200.00	14,400.00		9,000.00	7,200.00	
Kansas.....	137,122.84	12,083.86	1,726.07	67,088.76	26,602.07	7,705.17		1,965.98	7,200.00	5,200.00	14,400.00		9,000.00	7,200.00	
Kentucky.....	206,883.86	8,352.87	6,811.36	124,636.86	19,225.54	10,967.47		2,787.19	2,965.46	3,016.97	2,319.25		2,699.98	5,200.71	
Louisiana.....	139,226.59	9,318.18	1,260.45	73,081.23	41,556.29	7,149.12			600.00	1,253.25	850.00		600.00	460.00	
Maine.....	61,724.50	4,919.83	1,260.45	29,329.24	21,243.70	1,501.54			1,455.59	1,118.40	2,331.90		1,638.09	1,282.78	
Maryland.....	74,068.49	4,605.90	785.55	36,692.81	12,817.79	1,501.54			1,455.59	1,118.40	2,331.90		1,638.09	1,282.78	
Massachusetts.....	32,316.26	235.51		6,962.41	1,400.10	5,984.51			1,739.10	1,800.10			1,815.60	1,874.10	206.00
Michigan.....	167,549.32			120,693.23	21,635.77	25,220.32			7,870.00	4,525.52	11,608.28		2,300.21	3,921.85	
Minnesota.....	157,466.02	11,986.31	2,557.92	58,989.44	4,568.87	22,206.48			4,348.14	7,682.75	10,182.41		7,568.93	1,120.93	
Mississippi.....	181,201.86	12,049.68	7,136.55	129,358.61	18,436.86	3,046.16		1,339.94	5,674.25	3,488.50	3,818.09		7,568.93	1,063.86	
Missouri.....	210,645.26	6,759.60	1,000.00	26,604.01	7,650.00	4,459.89			4,326.66	5,136.67	4,716.67		5,093.33	4,880.00	
Montana.....	51,613.89	4,600.00	120.05	48,659.52	2,070.00	6,400.00									
Nebraska.....	108,389.25	4,700.00	120.05	48,659.52	2,070.00	6,400.00									
Nevada.....	16,862.72	10,174.39	583.66	4,604.67	3,180.00	1,837.54									
New Hampshire.....	28,033.64	9,484.33	121.43	6,847.00	6,721.29	5,384.38									
New Jersey.....	84,378.43	15,173.45	2,175.48	16,692.31	3,721.29	5,384.38									
New Mexico.....	42,616.21	5,099.96	5,442.63	12,412.99	36,670.93	20,445.04			5,286.27	2,946.97	4,487.58		3,457.56	1,575.67	1,642.84
New York.....	208,241.66	5,428.62	5,442.63	60,017.95	36,670.93	20,445.04		7,532.27	7,410.85	2,946.97	4,487.58		5,831.92	5,678.61	
North Carolina.....	238,426.37	3,400.00	1,411.57	97,327.75	80,508.63	5,193.24			5,983.33	5,900.00	11,966.67		9,600.00	3,000.00	
North Dakota.....	239,917.62	14,782.90	1,716.80	23,463.03	3,022.38	5,193.24			2,610.29	2,542.58	2,028.80		2,601.66	3,892.69	
Ohio.....	174,389.77	7,346.83	2,671.94	80,798.16	22,761.41	11,281.14		4,154.92	9,161.42	5,623.19	1,736.88		11,187.64	4,535.74	
Oklahoma.....	353,641.38	9,994.94	818.75	11,749.49	63,810.28	2,662.64			9,161.42	2,520.25	1,054.32		1,045.01	1,200.12	
Oregon.....	171,824.53	9,994.94	818.75	11,749.49	63,810.28	2,662.64			943.88	1,571.79	1,060.87		3,284.50	1,097.31	
Pennsylvania.....	353,641.38	34,342.49	729.53	213,737.72	85,021.81	8.79			1,340.03	737.20	13,436.11		137.35	2,537.09	
Rhode Island.....	111,680.24	3,233.84	327.52	1,005.91	1,537.73	1,931.38			708.56				8,494.29	3,094.31	
South Carolina.....	163,451.23	15,883.23	5,875.17	17,646.12	35,115.21	8,531.69			5,035.78	6,804.02	7,311.41		2,100.00	6,104.00	
South Dakota.....	69,037.45			41,631.64	5,550.00				600.00	2,400.82	2,100.00		2,288.10		
Tennessee.....	200,653.31	8,848.53	8,548.25	92,512.50	49,081.60	4,177.61		1,983.39	7,540.04	4,381.26	4,581.35			2,336.78	

Texas.....	357,874.42	29,950.01	4,466.52	161,380.00	108,257.61	1,393.53	---	---	---	6,398.53	2,747.47	2,365.46	---	5,404.08	2,413.34
Utah.....	33,816.87	4,474.63	---	16,308.73	3,408.56	---	---	---	---	2,281.75	1,194.33	2,399.96	---	1,813.29	1,299.96
Vermont.....	36,770.93	3,277.48	---	10,143.80	5,251.74	5,570.49	---	---	---	---	1,699.75	2,189.80	---	1,786.06	---
Virginia.....	190,554.95	18,498.47	501.56	101,769.09	23,868.37	5,456.47	---	---	---	3,647.45	3,800.00	2,101.29	---	3,666.58	2,954.16
Washington.....	77,121.21	15,342.29	2,077.83	33,178.80	8,258.44	7,986.54	---	---	---	788.41	1,443.07	3.80	---	3,406.82	1,770.36
West Virginia.....	130,873.37	10,387.27	665.47	71,323.60	19,665.16	11,418.72	---	---	---	3,400.00	75.00	---	---	3,000.00	---
Wisconsin.....	163,204.06	11,030.38	8,346.98	53,285.24	6,082.40	6,308.15	---	---	---	5,253.32	7,913.00	12,852.32	---	13,165.00	5,847.50
Wyoming.....	25,133.15	8,213.14	---	12,191.55	4,128.46	600.00	---	---	---	---	---	---	---	---	---
Hawaii.....	27,905.20	3,231.84	---	14,220.00	10,058.26	---	---	---	---	365.10	---	---	---	---	---
Total, 1930.....	6,182,936.00	431,964.15	100,083.17	2,666,396.19	1,135,297.27	305,283.73	23,944.53	21,397.22	146,467.99	137,065.96	175,879.39	12,775.82	158,434.81	108,085.53	5,209.29
1929.....	6,172,180.80	465,686.78	116,314.47	2,685,527.95	1,030,830.37	350,585.80	21,582.13	15,090.43	156,069.63	137,089.36	168,639.28	17,541.93	166,833.78	98,371.06	3,046.91
1928.....	5,880,000.00	467,466.38	91,233.78	2,652,167.00	1,021,850.25	372,020.37	35,189.04	13,273.50	135,317.99	111,494.68	150,932.24	16,335.29	139,049.89	87,358.18	---
1927.....	5,880,000.00	474,287.82	112,201.26	2,561,832.81	1,007,869.10	364,487.44	43,474.59	28,871.39	156,911.94	121,739.30	142,608.92	15,013.11	149,780.57	87,320.54	---
1926.....	5,880,000.00	514,714.28	143,188.39	2,543,586.90	964,378.07	358,598.55	52,729.07	33,037.96	136,255.72	106,794.63	150,440.07	14,738.70	151,594.87	100,227.86	---
1925.....	5,879,999.99	489,334.58	129,589.83	2,545,660.14	923,732.64	395,996.33	75,083.11	25,285.69	164,480.17	115,788.09	169,368.58	13,478.82	174,800.00	78,561.76	---
1924.....	5,880,000.00	567,299.02	107,430.35	2,499,648.20	885,551.85	347,032.94	362,896.50	25,595.61	127,715.52	115,383.23	146,225.26	15,068.10	192,313.17	---	---
1923.....	5,880,000.00	560,818.85	134,982.11	2,484,671.37	885,893.81	388.141	33,921.69	57,557.00	135,853.68	112,673.45	149,978.94	13,828.80	178,711.34	---	---
1922.....	5,880,000.00	534,939.13	107,237.37	2,585,672.90	690,124.65	367,674.18	323,457.69	24,013.74	151,306.74	104,173.38	149,102.80	15,032.24	155,850.69	---	---
1921.....	5,080,000.00	510,671.70	96,897.63	2,314,067.79	643,712.65	338,121.77	163,028.85	29,275.53	117,477.14	83,263.80	151,544.79	14,183.78	124,471.96	---	---
1920.....	5,580,000.00	497,135.73	113,328.01	1,980,498.67	643,380.58	319,561.57	169,269.04	35,041.37	87,871.04	67,003.77	102,469.90	12,947.38	97,415.30	---	---
1919.....	2,580,000.00	497,041.99	103,120.93	665,145.98	393,631.98	143,219.87	---	40,430.03	93,866.43	59,589.20	85,229.65	14,524.65	101,141.49	---	---
1918.....	2,080,000.00	390,545.48	76,910.28	584,815.72	356,475.39	112,076.34	---	44,515.12	68,268.80	40,519.09	67,341.73	14,700.71	73,316.76	---	---
1917.....	1,580,000.00	249,738.80	43,881.48	453,417.17	261,229.14	105,290.22	---	69,425.12	53,018.49	26,307.94	49,586.76	11,807.83	56,668.96	---	---
1916.....	1,080,000.00	177,213.30	27,867.77	289,708.77	174,753.22	63,189.11	---	63,125.80	30,305.43	21,108.07	38,365.08	9,583.93	33,352.22	---	---
1915.....	480,000.00	86,278.39	8,241.16	128,083.33	69,890.05	32,944.29	---	33,821.65	8,640.84	5,735.83	16,269.72	3,930.67	9,191.99	---	---

¹ Prior to 1920 included home-economics specialists.

² Prior to 1920 included under home demonstration work.

³ Prior to 1925 included foods and nutrition, home management, and clothing.

TABLE 20.—Expenditures of funds from the United States appropriation of May 8, 1914 (Federal Smith-Lever) for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by projects, and totals for 1915-1929—Continued

State	Cloth- ing	Home manage- ment	Horticul- ture	Botany and plant pathol- ogy	Ento- mology, apical culture, ornith- ology	Rodent pests	Forestry	Agricul- tural engineer- ing	Farm manage- ment	Rural organi- zation	Market- ing	Exhibits and fairs	Informa- tion	Miscel- laneous special- ists	Unex- pended balance
Alabama	\$3,300.00	\$3,300.00	\$5,944.38		\$3,000.00			\$10,153.75			\$8,320.11		\$3,898.66		
Arizona															
Arkansas	880.78	2,344.83	1,650.78				\$343.89		\$3,349.89		2,581.07		7,749.06		
California									2,604.10						
Colorado	840.37	2,480.33	1,940.51						3,464.00		2,703.36		2,293.40		\$5.00
Connecticut	2,800.00	3,150.00	4,383.98		1,811.00			1,625.00			3,332.99		1,666.29		
Delaware				\$251.42	298.42										
Florida			633.33	633.34	633.33										
Georgia	2,400.00	2,700.00	8,700.00					4,691.67	2,400.00		4,200.00	\$2,700.00			
Idaho	2,180.00		1,873.00												
Illinois	3,686.53	6,573.91	6,888.99		566.82			3,502.03	7,740.53	\$1,395.77	966.06		3,789.12		
Indiana	2,445.27	6,059.28	7,299.26	7,704.28				2,579.04	3,883.52		4,428.00				
Iowa	7,400.00	14,200.00	7,200.00	1,800.00	3,600.00			1,600.00	1,200.00	1,300.00			2,123.18		
Kansas	2,500.00		1,859.57		77.11			5,765.20	1,907.30		89.12		4,533.42		
Kentucky	1,926.11	2,457.52						5,986.96	1,438.93		2,863.52				
Louisiana	600.00		1,200.00		1,200.00			750.00					4,932.63		
Maine										120.00	505.00		2,732.24		
Maryland	1,574.31		3,717.39	541.78	647.42				1,239.00		691.38				
Massachusetts	1,600.00	1,267.50	5,500.95												
Michigan				3,336.28			360.00		6,520.00	900.00	2,516.92		420.00		
Minnesota	7,294.57	3,673.34	9,088.78							5,206.90	11,735.47		791.75		
Mississippi	3,816.53	2,957.02	1,574.96					2,568.24	1,509.66	1,228.35	1,523.60		3,071.69		
Missouri	1,500.00	1,500.00						1,300.00							
Montana			2,550.00						2,226.34		1,025.00		2,350.00		
Nebraska	3,475.00	4,280.00			1,333.34			5,046.67					1,500.00		
Nevada													1,610.00		
New Hampshire		2,900.00					1,962.97	993.51	1,930.01				7,433.75		
New Jersey	336.37	1,399.45	5,920.65						3,592.06						
New Mexico			1,238.78						1,241.64						
New York	9,129.90	9,984.01	1,539.31	9,007.25	4,512.71		1,132.66	3,450.48	7,560.58	495.00			93.90		178.65
North Carolina	3,000.00		6,100.00	2,700.00	5,640.00			3,300.00					1,926.90		
North Dakota	6,104.02	1,334.44		6,969.34				1,685.62	3,456.71		831.83		1,650.00		
Ohio	5,212.69	2,170.33	8,728.95	6,969.34	12,780.37			2,607.24	8,743.76		980.66		3,067.27		
Oklahoma	773.88	753.94	2,191.03		1,031.30			917.79	596.62		5,991.66		3,232.15		
Oregon			1,888.88						837.97	4.52	9.05				
Pennsylvania	1.20		9.70	1,616.44	14.33										
Rhode Island			1,297.58												
South Carolina			6,330.42		6,477.52								795.91		
South Dakota	2,100.00		1,050.00		1,050.00			900.00	2,212.33		9,134.75		6,333.34		703.17

Tennessee	1, 103.82	2, 300.27	2, 643.73	2, 868.79	2, 920.95	2, 670.11	2, 700.00	886.82
Texas	3, 208.12	2, 822.35	2, 643.73					
Utah	1, 709.00							
Vermont	2, 198.67							
Virginia	200.00	2, 039.37	3, 133.69	4, 131.95	1, 901.58			250.00
Washington		1, 206.77			1, 061.06	2, 122.13		3, 160.00
West Virginia	1, 429.95				251.87	1, 033.99		878.27
Wisconsin		3, 200.00		50.00				1, 400.00
Wyoming	7, 905.00	7, 900.00		750.00		2, 200.00		1, 000.00
Hawaii								
Total, 1930	90, 973.47	130, 229.46	43, 093.82	4, 599.52	77, 115.41	28, 443.83	2, 700.00	78, 450.95
1929	111, 806.02	129, 339.42	41, 694.31	4, 826.69	60, 597.74	15, 242.78	76, 300.88	83, 749.26
1928	95, 965.00	102, 417.32	38, 474.93	3, 804.14	39, 587.70	11, 747.46	67, 601.03	73, 007.99
1927	110, 290.84	105, 266.57	39, 634.31	4, 472.60	42, 761.71	10, 864.70	75, 217.67	13, 861.99
1926	114, 818.52	109, 260.26	48, 146.55	1, 230.03	48, 034.13	10, 918.77	76, 060.11	17, 736.55
1925	98, 595.84	114, 473.14	46, 623.74	7, 053.51	51, 688.86	14, 044.63	75, 929.93	15, 324.01
1924		105, 347.12	54, 154.16	9, 184.80	59, 303.95	24, 304.54	91, 555.31	20, 394.99
1923		113, 766.16	54, 351.72	4, 526.43	54, 910.50	13, 395.83	86, 237.42	345.98
1922		119, 494.94	42, 662.39	409.84	57, 612.13	4, 552.23	70, 812.25	10, 979.02
1921		120, 881.01	39, 347.39	2, 248.18	75, 761.33	7, 313.30	61, 357.69	3, 289.89
1920	94, 734.69	38, 021.20	23, 249.32	2, 089.12	58, 678.38	8, 660.11	61, 803.38	3, 492.08
1919	80, 593.31	40, 819.23	21, 307.37	1, 201.41	50, 945.46	20, 794.66	57, 132.80	8, 773.70
1918	73, 870.57	24, 800.53	7, 659.64	4, 591.98	24, 113.45	13, 744.60	33, 628.68	17, 186.07
1917	43, 773.14	11, 691.68	7, 937.23	358.45	32, 780.96	10, 510.03	2, 455.40	32, 660.70
1916	42, 943.87	6, 801.49	4, 603.57		34, 004.56	3, 197.59	7, 204.80	31, 731.84
1915	16, 303.53	440.00			4, 369.31	126.00	3, 712.95	43, 070.27

* Prior to 1925 included under home economies.

TABLE 21.—Expenditures from the United States appropriation of May 8, 1914 (State Smith-Lever) for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by projects, and totals for 1916-1929

State	Total	Adminis- tration	Printing and dis- tribution of publi- cations	County agent work	Home dem- onstration work	Boys' and girls' club work	Home- economies special- ists ?	Exten- sion schools	Animal hus- bandry	Poultry	Dairying	Animal diseases	Agron- omy	Foods and nutri- tion	Child care and train- ing
Alabama	\$203,041.91	\$9,834.28	\$7,380.65	\$91,329.30	\$72,784.48	\$1,374.73	\$13.55	\$736.61	\$736.61	\$736.61	\$736.61		\$1,757.75	\$1,430.42	
Arizona	23,920.94	6,583.68	206.52	5,870.67	5,870.67	1,284.17	116.10	2,747.17	2,747.17	1,119.08	533.00		2,113.59	2,670.00	
Arkansas	161,397.98	7,753.25		85,550.02	52,756.67			1,995.00	1,995.00	1,350.00	1,650.00				
California	120,921.71			27,276.05		15,899.64			1,600.00	1,600.00	1,740.00		1,600.00	1,400.00	
Colorado	53,703.73	4,250.00	965.09	27,276.05	2,163.56	15,899.64			1,600.00	1,600.00	1,740.00		1,600.00	1,400.00	
Connecticut	49,067.58	8,236.27	3,091.44		1,188.93	5,287.32	\$1,307.81		680.90	5,519.80	7,291.06		1,598.53	1,542.11	
Delaware	11,288.65	5,070.43		2,803.31	1,575.83	1,580.48				1,315.47	1,525.83			113.10	
Florida	67,646.71	3,282.30	5,209.19	34,287.05	15,041.44	1,901.27	146.58		5,375.81	5,203.75	3,084.39	82,269.72		1,012.15	
Georgia	239,382.01	4,553.53		82,401.52	67,873.69	7,524.51			3,670.06				9,832.89	970.73	\$42.47
Idaho	34,541.76	300.00		15,681.52	5,918.33	425.00							1,600.00		
Illinois	229,624.34			225,620.96	4,003.38										
Indiana	159,833.14			159,833.14											
Iowa	168,775.89			168,775.89											
Kansas	127,122.84	1,077.13	702.50	39,780.81	4,899.65	3,244.19	3,433.18	8,876.01	8,876.01	8,199.37	9,117.96	3,605.76	12,751.92	1,807.11	
Kentucky	196,833.86	11,679.99	810.00	70,962.89	24,656.17	21,151.24		11,559.98	11,559.98	8,653.32	4,125.27	3,100.00	10,093.34	3,600.00	
Louisiana	129,226.59	17,800.82	2,688.94	42,768.41	10,634.34	4,166.36		3,274.40	3,274.40	8,029.34	4,137.02		3,444.27	2,523.09	
Maine	51,724.50	5,106.50		12,782.75	1,572.71	6,589.28			3,085.29	3,572.22	3,815.86		3,363.76	3,121.09	
Maryland	64,068.49	6,598.69	1,396.42	23,966.30	6,813.34	3,103.10				3,072.08	3,154.30			1,635.05	
Massachusetts	22,316.26			22,316.26											
Michigan	157,549.32	10,420.00		2,523.00	186.67	8,568.25		7,971.42	7,971.42	11,973.30	14,186.55		31,944.10	5,853.30	
Minnesota	147,466.02	1,100.00		116,400.55	5,875.00	6,888.00		1,607.97	1,607.97	212.68	5,077.90		2,298.22		
Mississippi	171,201.86	10,863.63		95,629.55	45,559.91	13,418.29			8,998.42	6,391.97	6,437.55		12,243.75	2,746.77	
Missouri	200,645.26	3,823.53	6,193.91	88,871.90	12,683.07	12,510.49	741.31			1,600.00				2,100.00	
Montana	41,613.89	5,400.00		13,849.40	2,000.00	1,690.11			3,193.37	2,499.17	3,009.48		3,824.48	1,566.42	
Nebraska	98,386.25	11,306.06	1,464.70	34,323.78	5,374.46	9,899.32				1,048.05	1,970.00				
Nevada	6,862.72			3,019.27	825.40										
New Hampshire	18,033.64			12,000.00	6,033.64	13,333.38				7,322.76	4,655.65		2,160.00		1,800.00
New Jersey	74,378.43			12,853.32	11,828.98										
New Mexico	32,616.21	9,387.52	2,099.87	14,781.01	1,970.37				3,600.00					3,500.00	
New York	198,241.56			97,673.10	72,102.23	6,415.39	1,522.19	3,600.00	2,163.13	2,051.71	4,326.25		3,800.18	612.51	
North Carolina	228,426.37	14,007.36	6,449.93	129,667.37	42,573.50	3,630.88		1,496.68	1,496.68	1,316.25	1,800.00	2,730.00	1,800.00	2,925.00	
North Dakota	61,683.39	6,085.51	336.29	24,674.97	2,379.98	3,024.58		8,000.00	8,000.00	6,100.00	3,437.78		12,033.33	3,416.67	
Ohio	229,917.62	1,741.67		127,303.20	13,300.00	20,372.05		3,950.00	3,950.00	6,100.00	4,347.78		3,200.00	2,900.00	
Oklahoma	164,389.77	20,574.64		75,024.25	16,180.00	8,058.96		2,333.33	2,333.33	180.02	1,800.00		20,523.76	1,666.67	
Oregon	43,324.53			15,261.87	550.00	5,081.43		17,342.03	17,342.03	19,257.43	20,427.73			1,155.45	
Pennsylvania	343,641.38	14,291.50	420.34	89,196.16	26,515.54	24,791.83	8.61	3,687.52	3,687.52	1,900.01	92.92		4,737.53	3,500.00	
Rhode Island	1,680.24	354.93		394.37	74.92	35.80		8.61							
South Carolina	153,451.23	9,025.03		84,018.76	39,358.76	12,067.29		3,687.52	3,687.52	1,999.28	1,601.23	1,506.81	4,737.53	2,633.16	
South Dakota	59,037.45	12,604.65	5,227.82	5,978.71	2,547.04			1,600.00	1,600.00	1,999.28	1,601.23	1,506.81	1,726.01	2,633.16	
Tennessee	190,653.31	17,062.84	2,292.28	113,023.51	26,931.24	3,371.63	1,113.50	7,817.56	7,817.56	2,381.03	3,568.60		1,627.87	1,075.60	

	347, 874.42 ¹	910.84	215, 092.19	100, 120.37		5, 448.51	2, 833.34	2, 833.33	333.33	1, 200.00
Texas.....	23, 816.87		13, 589.40	3, 174.59						1, 100.04
Utah.....	26, 770.93		8, 886.61	4, 034.58						1, 184.85
Vermont.....	180, 554.95	9, 919.51	62, 516.00	50, 110.67	4, 153.70	5, 885.94	1, 120.53	2, 601.71		1, 815.60
Virginia.....	67, 121.21	1, 922.50	41, 022.36	3, 776.13	2, 404.86	1, 870.74	3, 295.78	12, 261.45		2, 959.79
Washington.....	120, 573.37		69, 648.05	25, 011.56	17, 103.94	1, 907.02	3, 400.00	1, 751.97		774.79
West Virginia.....	153, 204.06	1, 359.71	85, 168.80	4, 749.32		1, 998.64	2, 114.44	4, 975.31		7, 834.03
Wisconsin.....	15, 133.15		13, 800.01	1, 200.00	2, 575.18					2, 108.27
Wyoming.....	17, 905.20	1, 600.00	1, 059.84	3, 170.18		4, 436.00				
Hawaii.....										
Total, 1930.....	5, 692, 936.00	67, 511.85	2, 900, 226.89	806, 753.90	258, 252.85	12, 501.95	12, 045.81	136, 468.12	142, 408.79	65, 893.94
1929.....	5, 682, 180.80	300, 878.57	66, 538.82	2, 896, 354.18	21, 546.70	13, 341.86	122, 051.67	131, 251.46	144, 157.74	9, 126.79
1928.....	5, 400, 000.00	248, 360.35	66, 577.46	2, 710, 846.14	820, 966.17	233, 896.16	171, 881.95	128, 812.75	122, 290.63	150, 995.94
1927.....	5, 400, 000.00	240, 064.19	98, 681.84	2, 876, 107.68	728, 071.31	207, 667.79	36, 352.87	12, 261.55	150, 433.55	117, 868.01
1926.....	5, 400, 000.00	238, 648.04	104, 493.36	2, 861, 288.71	759, 181.86	222, 413.89	46, 202.49	15, 664.10	145, 205.90	118, 739.28
1925.....	5, 399, 999.99	230, 230.20	80, 633.60	2, 871, 202.68	764, 556.32	180, 045.94	114, 996.88	15, 716.27	150, 132.86	109, 889.36
1924.....	5, 400, 000.00	255, 911.89	81, 005.72	2, 962, 393.16	750, 939.18	194, 681.32	165, 523.64	13, 984.37	176, 842.99	103, 904.31
1923.....	5, 400, 000.00	332, 631.65	74, 414.38	2, 940, 071.60	831, 627.67	193, 467.20	104, 525.11	5, 506.33	150, 062.17	100, 013.09
1922.....	5, 100, 000.00	299, 388.81	78, 678.18	2, 669, 702.27	775, 682.83	228, 517.62	200, 301.69	16, 517.56	117, 689.62	89, 407.18
1921.....	4, 600, 000.00	239, 526.68	70, 823.38	2, 348, 735.60	761, 014.77	215, 447.91	94, 802.54	22, 731.78	104, 030.07	77, 498.14
1920.....	4, 100, 000.00	217, 594.18	58, 956.38	2, 204, 209.25	589, 724.44	178, 287.12	117, 032.75	47, 019.29	84, 244.58	61, 520.81
1919.....	2, 100, 000.00	252, 329.45	55, 940.79	941, 902.93	293, 869.64	112, 706.28		28, 667.68	53, 747.75	34, 779.81
1918.....	1, 600, 000.00	178, 212.44	40, 130.89	766, 416.54	197, 262.21	80, 315.51		33, 850.11	44, 274.89	22, 973.75
1917.....	1, 100, 000.00	97, 302.53	34, 819.50	541, 495.05	126, 235.78	50, 209.68		36, 501.94	27, 199.22	12, 722.78
1916.....	600, 000.00	90, 055.50	283, 077.42	68, 468.44	28, 473.54		25, 754.65	7, 102.61	9, 905.43	2, 406.88

¹ Prior to 1920 included home-economics specialists.² Prior to 1920 included under home demonstration work.³ Prior to 1925 included foods and nutrition, home management, and clothing.⁴ Prior to 1925 included under home economics.

TABLE 21.—Expenditures from the United States appropriation of May 8, 1914 (State Smith-Lever) for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by projects, and totals for 1916-1929—Continued

State	Clothing	Home management	Horticulture	Botany and plant pathology	Entomology, apiculture, ornithology	Rodent pests	Forestry	Agricultural engineering	Farm management	Rural organization	Marketing	Exhibits and fairs	Information	Miscellaneous specialists	Unexpended balance
Alabama	\$1,208.81	\$1,126.75	\$2,886.53		\$1,073.49			\$1,825.13			\$4,872.10		\$1,864.11		
Arizona															
Arkansas	705.00	1,100.00	1,349.23								1,862.00		427.12		
California	1,500.00	900.00	900.00						\$2,113.52		308.33		1,994.94		
Colorado	1,419.09	1,216.43	4,741.59				\$152.85	946.69	1,689.30		2,298.73				\$5.00
Connecticut															
Delaware				\$14.05	548.71										
Florida	1,569.51	762.25	325.72	325.73	131.41								2,948.25		
Georgia	1,955.00	6,411.83			325.72								13,771.38		
Iaho		1,580.00													
Illinois					1,080.00										
Indiana															
Iowa															
Kansas	5,935.32	3,291.41	4,324.17	3,714.20	4,925.27	\$181.14		2,206.81	832.79		3,434.48				
Kentucky	5,400.00		7,109.00						3,405.00		3,563.66				
Louisiana	3,540.02		6,307.25		5,083.25			2,475.60		\$3,578.32	2,834.35		5,880.79		
Maine	3,318.45		2,227.72				3,211.01		4,179.18	1,000.00			1,502.55		
Maryland	1,587.81		3,518.28	207.69	23.23										
Massachusetts															
Michigan	5,086.34	7,699.07	17,963.28	600.00	1,241.60			10,259.88	656.64		11,056.00		9,949.92		
Minnesota							280.71		1,602.65				5,222.38		
Mississippi	6,205.95	3,728.12		2,855.11				5,281.65					448.83		
Missouri	2,100.00	1,254.38			4,218.50			4,218.50	3,544.99	3,987.75	3,294.07		6,019.65		
Montana									1,700.00				3,920.00		
Nebraska	1,880.31	2,483.30	1,661.39		467.67			6,018.13	3,209.16		465.14		5,742.91		
Nevada															
New Hampshire															
New Jersey			8,640.00					1,333.34	720.00				4,377.44		
New Mexico				4,000.00				2,500.00	3,250.00						178.65
New York	653.59	599.52	2,351.50	974.01	2,734.45		1,124.41	2,263.32					8,439.75		
North Carolina	3,743.76	1,701.67						1,714.18	3,530.00		250.00		1,514.52		
North Dakota	5,909.00	6,001.61	11,400.00					3,400.00	3,849.09				7,400.00		
Ohio	2,827.80		3,950.00		2,700.00			3,200.00	2,322.21				4,487.55		
Oklahoma			2,278.58										4,425.00		
Oregon	18,615.31		21,092.30	11,432.21	20,573.27		7,875.11		10,279.02	5,284.13			4,000.00		
Pennsylvania															
Rhode Island															
South Carolina															
South Dakota	1,211.63		689.27					903.00	1,784.10		4,341.06		6,381.96		
Tennessee	387.03	387.02	1,709.95		689.25				3,283.45		1,390.87		2,100.00		

[illegible]

TABLE 22.—Expenditures from the United States appropriation authorized May 22, 1928 (Federal Capper-Ketcham), for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by projects, and total for 1929

State	Total	Adminis- tration	Printing and distri- bution of publica- tions	County agent work	Home demon- stration work	Boys' and girls' club work	Extension schools	Animal husbandry	Poultry	Dairying	Agronomy	Foods and nutrition
Alabama.....	\$37,832.79		\$593.07	\$17,659.18	\$16,140.24	\$3,440.30						
Arizona.....	22,100.88	\$161.09		8,801.65	10,390.38	1,570.08		\$134.63	\$10.72		\$1,032.33	
Arkansas.....	34,175.28		11.73	18,934.84	15,226.28		\$2.43					
California.....	30,620.32			14,483.01	16,137.31							
Colorado.....	24,620.64	278.84	46.50	11,177.94	12,862.64							
Connecticut.....	24,308.64			3,749.81	10,216.00	9,987.02						
Delaware.....	20,991.46	114.33		3,000.00	7,641.50	6,500.00						\$5,375.29
Florida.....	25,941.28			9,863.31	12,785.15	3,292.82						
Georgia.....	41,024.48			23,021.66	11,922.22							
Idaho.....	23,033.74			11,358.56	8,164.23	3,469.90				\$40.95		2,256.69
Illinois.....	40,167.48	98.92			10,959.89	29,108.67						
Indiana.....	34,823.28			4.81	16,273.43	17,418.58				1.01	340.02	
Iowa.....	31,164.96			6,000.28	18,643.27	10,179.73						
Kansas.....	37,291.95			12,949.78	13,698.99	4,516.19						
Kentucky.....	31,349.73	657.58	6.67	22,752.76	14,539.19							
Louisiana.....	31,849.86			20,105.79	10,027.35	86.63			24.99	10.25	9.50	26.11
Maine.....	25,627.02				7,364.29	17,178.57						
Maryland.....	25,627.02			15,664.26	9,940.71	22.05						
Massachusetts.....	21,960.00			1,600.00	1,600.00	15,832.00						
Michigan.....	33,837.26			18,877.34	5,400.00	4,800.00			336.91	269.02	269.55	
Minnesota.....	32,951.66				14,240.55	14,964.30						
Mississippi.....	35,036.35			14,276.36	15,300.59	500.00						
Missouri.....	37,622.30			13,555.53	20,816.22			116.72	565.00	868.00	727.65	35.77
Montana.....	23,654.87		312.25	11,851.81	7,079.10	4,212.50						
Nebraska.....	28,641.35			6,924.20	17,504.65							
Nevada.....	20,602.75			7,560.00	13,042.75							
New Hampshire.....	21,583.90		61.06	7,975.00	1,958.33	8,664.48						625.03
New Jersey.....	26,532.51			569.00	9,535.15	12,603.36						
New Mexico.....	22,864.62			5,821.66	17,042.96							
New York.....	37,411.20			12,410.90	10,543.63	12,714.88						
North Carolina.....	40,062.27			19,483.93	16,578.34							
North Dakota.....	25,417.54			13,885.98	11,531.56							
Ohio.....	40,193.24	116.55	1,868.95	15,789.00	13,775.88	7,351.61						
Oklahoma.....	34,438.05	4.29		14,289.99	17,293.89	433.33						
Oregon.....	23,805.11	2,500.00		6,719.83	12,116.94	200.00		875.00				
Pennsylvania.....	50,181.39			7,250.00	21,786.12					1,386.02		
Rhode Island.....	20,147.57			5,208.77	6,695.57	6,428.35				4,200.00		
South Carolina.....	33,477.33	264.20		17,100.17	16,377.16				186.69			
South Dakota.....	25,185.15				12,304.15	12,881.00						
Tennessee.....	36,744.72			18,635.40	18,109.32							

[illegible]

TABLE 23.—Expenditures from the United States appropriation (State Capper-Ketcham) for cooperative agricultural extension work in each State and Hawaii for the year ended June 30, 1930, by projects

State	Total	Adminis- tration	Printing and distri- bution of publica- tions	County agent work	Home dem- onstrat- ion work	Boys' and girls' club work	Home-econ- omics specialists	Animal husbandry	Poultry	Dairying	Animal diseases
Alabama.....	\$17,832.79			\$11,590.39	\$6,236.40						
Arizona.....	2,100.88	\$35.10		2,046.61	19.17						
Arkansas.....	14,175.28			6,049.31	8,125.97						
California.....	10,620.32				10,620.32						
Colorado.....	4,716.70	288.34		2,116.66	2,341.70				\$1,272.55	\$270.40	
Connecticut.....	4,308.64		\$121.10			\$300.89	\$143.84		991.46		
Delaware.....	991.46										
Florida.....	5,941.28			5,941.28							
Georgia.....	21,024.48			11,024.48	10,000.00						
Idaho.....	3,033.74	255.33	461.57	1,005.67	1,310.07						
Illinois.....	20,167.48				20,167.48						
Indiana.....	14,037.85			14,037.85							
Iowa.....	14,823.28			7,137.74							
Kansas.....	11,164.06			11,164.06	7,685.54						
Kentucky.....	17,291.95			17,291.95							
Louisiana.....	11,849.73				11,289.37	1,379.29					
Maine.....	4,542.86										
Maryland.....	5,627.02				5,627.02						
Massachusetts.....	1,960.00			1,960.00							
Michigan.....	13,837.26			1,986.45		11,850.81			158.99		\$88.75
Minnesota.....	12,961.66	194.11		12,151.01							
Mississippi.....	15,036.35			15,036.35							
Missouri.....	17,622.30			17,622.30							
Montana.....	3,654.87			3,203.31							
Nebraska.....	8,641.35	1,064.08		1,744.75	1,703.79	627.84	\$1,980.63		56.45	209.55	
Nevada.....	620.75				602.75						
New Hampshire.....	1,583.90				1,583.90	95.00					
New Jersey.....	6,532.51										
New Mexico.....	2,864.62			2,047.09	817.53						
New York.....	17,411.20			3,600.00		13,769.41					
North Carolina.....	20,062.27			20,062.27					225.00	300.00	600.00
North Dakota.....	4,517.54										
Ohio.....	20,193.24			9,481.76	9,420.83						
Oklahoma.....	14,438.05			7,997.77	1,291.13				400.00	611.08	
Oregon.....	3,805.11	761.02				1,500.00		466.66	1,200.00		
Pennsylvania.....	30,181.39			18,911.12							
Rhode Island.....	147.57										
South Carolina.....	13,477.33				6,000.00						
South Dakota.....	5,185.15			7,477.33							
Tennessee.....	16,744.72				16,744.72						1,593.53

Utah.....								53.42				
Vermont.....												
Virginia.....												4,831.15
Washington.....							3,489.07					
West Virginia.....												
Wisconsin.....												
Wyoming.....												
Hawaii.....												977.73
Total, 1930.....	3,860.74	2,900.00	2,863.13	9,315.18	4,714.15	125.00	509.21	2,746.63	453.14	1,039.30	1,382.65	19,163.55

TABLE 24.—*Sources of offset to Federal Smith-Lever and Capper-Ketcham funds for the fiscal year ended June 30, 1930, and totals for 1916-1929*

State	Total	State and college	County	Farmers' organizations, etc.	Unexpended balance
Alabama	\$220,874.70	\$175,861.24	\$45,013.46		
Arizona	26,021.32	26,021.32			
Arkansas	175,573.26	120,546.95	55,026.31		
California	131,542.03	131,542.03			
Colorado	58,420.43	43,510.66	14,904.77		\$5.00
Connecticut	53,366.22	53,366.22			
Delaware	12,280.11	12,280.11			
Florida	73,587.99	48,872.25	24,715.74		
Georgia	260,406.49	151,180.45	109,226.04		
Idaho	37,575.50	37,575.40			.10
Illinois	249,791.82	136,253.12		\$113,538.70	
Indiana	173,870.99	83,405.49	90,465.50		
Iowa	183,599.17		183,599.17		
Kansas	138,287.80	91,841.56	46,446.24		
Kentucky	214,175.81	142,241.30	71,934.51		
Louisiana	140,576.32	95,850.36	44,665.60		60.36
Maine	56,267.36	56,267.36			
Maryland	69,695.51	69,695.51			
Massachusetts	24,276.26		24,276.26		
Michigan	171,386.58	166,877.13	4,509.45		
Minnesota	160,417.68	107,552.95	52,779.68		85.05
Mississippi	186,238.21	98,149.83	88,088.38		
Missouri	218,267.56	119,319.70	98,947.86		
Montana	45,268.76	24,599.47	20,217.73		451.56
Nebraska	107,030.60	80,226.10	26,804.50		
Nevada	7,465.47	7,465.47			
New Hampshire	19,617.54	19,617.54			
New Jersey	80,910.94	80,910.94			
New Mexico	35,480.83	32,616.21	2,864.62		
New York	215,652.76	106,530.38	108,901.94		220.44
North Carolina	248,488.64	158,582.86	89,905.78		
North Dakota	67,100.93	47,786.90	19,314.03		
Ohio	250,110.86	185,009.58	63,810.63		1,290.65
Oklahoma	178,827.82	133,203.57	45,624.25		
Oregon	47,129.64	47,122.32			7.32
Pennsylvania	373,822.77	276,541.42	86,011.08		11,270.27
Rhode Island	1,827.81	977.07			850.74
South Carolina	166,928.56	98,843.80	68,084.76		
South Dakota	64,222.60	64,222.60			
Tennessee	207,398.03	207,398.03			
Texas	378,427.59	254,245.36	124,182.23		
Utah	28,084.32	28,084.32			
Vermont	29,122.18	29,122.18			
Virginia	196,412.76	193,903.17	2,509.59		
Washington	73,016.34	28,593.82	39,591.37		4,831.15
West Virginia	131,489.45	20,901.82	110,587.63		
Wisconsin	166,659.69	128,138.71	38,520.98		
Wyoming	16,462.26	16,462.26			
Hawaii	19,477.73	18,500.00			977.73
Total, 1930	6,192,936.00	4,257,816.84	1,801,530.09	113,538.70	20,050.37
1929	5,692,936.00	3,846,324.87	1,704,904.94	118,547.67	23,158.52
1928	5,400,000.00	3,739,918.23	1,541,568.37	117,308.41	1,204.99
1927	5,400,000.00	3,718,271.77	1,572,968.24	107,196.73	1,563.26
1926	5,400,000.00	3,620,775.64	1,670,811.48	107,595.98	816.90
1925	5,399,999.99	3,657,975.00	1,634,787.09	106,321.80	916.10
1924	5,400,000.00	3,542,542.33	1,729,371.54	107,691.14	20,394.99
1923	5,400,000.00	3,463,045.41	1,769,973.22	107,798.26	59,183.11
1922	5,100,000.00	3,218,002.63	1,712,675.09	99,671.73	69,650.55
1921	4,600,000.00	2,966,461.61	1,518,778.45	8,808.44	105,951.50
1920	4,100,000.00	2,630,754.55	1,095,923.84	257,665.97	115,655.64
1919	2,100,000.00	1,586,066.42	316,367.59	156,394.03	41,171.96
1918	1,600,000.00	1,313,330.47	215,077.20	59,658.62	11,933.71
1917	1,100,000.00	952,114.31	94,556.74	48,383.33	4,945.62
1916	600,000.00	497,484.18	69,226.79	31,212.76	2,076.27

TABLE 25.—Expenditures of funds from all sources for cooperative agricultural extension work in States, Hawaii, and Porto Rico for the year ended June 30, 1930, by sources of funds, and totals for 1915–1929

APPENDIX

129

State	Grand total	Total Federal funds	Total within the State	Funds from Federal sources				Funds from within State			
				U. S. Department of Agriculture		Federal Clarke-McNary	Federal Smith-Lever	Federal Capper-Ketcham	State and college	County	Farmers' organizations, etc.
				Farmers' cooperative demonstrations	Other						
Alabama.....	\$706,137.01	\$283,827.50	\$422,309.51	\$30,372.80		\$1,980.00	\$213,041.91	\$37,832.79	\$258,784.33	\$147,725.92	\$15,799.26
Arizona.....	143,764.44	67,509.94	76,254.50	11,488.62			33,920.44	22,100.88	49,357.60	26,819.90	77.00
Arkansas.....	577,901.90	255,800.17	322,095.73	29,042.54	\$19,375.37	1,815.00	171,397.98	34,175.28	122,361.95	191,269.78	8,464.00
California.....	803,654.13	186,950.06	616,704.07	23,428.03		1,980.00	130,921.71	30,620.32	104,274.17	206,429.90	
Colorado.....	277,428.70	113,955.90	163,472.80	22,040.55	3,499.92		63,698.73	24,716.70	78,125.38	85,347.42	
Connecticut.....	290,868.04	95,319.74	195,548.30	10,953.56		999.96	59,057.58	24,308.64	134,405.62	42,375.00	18,767.68
Delaware.....	58,811.96	46,531.85	12,280.11	4,251.74			21,288.65	20,991.46	12,280.11		
Florida.....	363,348.23	124,048.82	239,299.41	20,460.83			77,646.71	25,941.28	79,736.62	159,562.79	
Georgia.....	801,700.73	327,353.38	474,347.35	35,186.89		1,760.00	249,382.01	41,024.48	249,019.61	225,327.74	
Idaho.....	244,202.97	91,660.83	152,542.14	19,480.43	2,700.00	1,905.00	44,541.76	23,033.64	71,163.63	62,132.20	19,246.31
Illinois.....	1,049,059.87	292,768.99	756,290.88	11,477.23		1,499.94	239,624.34	40,167.85	152,041.21	203,867.88	50,050.51
Indiana.....	622,976.05	215,303.45	407,672.60	11,190.46		242.00	169,833.14	34,037.85	153,754.21	203,867.88	50,050.51
Iowa.....	1,068,632.65	228,370.57	840,262.08	12,791.40		1,980.00	178,775.89	34,823.28	206,262.08	300,000.00	274,000.00
Kansas.....	701,962.79	179,914.62	522,048.17	11,026.82			137,122.84	31,164.96	153,497.96	277,610.56	90,939.65
Kentucky.....	555,887.92	274,242.19	281,645.73	30,066.38			206,883.86	37,291.95	142,241.30	137,230.58	2,173.85
Louisiana.....	496,950.25	215,079.08	281,870.57	30,829.21	11,838.47	1,896.04	139,226.59	31,289.37	97,900.00	181,647.69	2,232.88
Maine.....	196,240.03	104,246.46	91,933.17	17,979.10			61,724.50	24,542.86	56,948.10	25,776.97	9,268.50
Maryland.....	370,958.41	118,628.27	252,330.14	17,018.76		1,914.00	74,068.49	25,627.02	175,221.44	66,712.00	10,396.70
Massachusetts.....	434,598.00	79,609.84	354,988.16	23,353.58		1,980.00	32,316.26	21,960.00	100,058.22	254,929.94	
Michigan.....	739,672.01	213,286.71	526,385.30	3,920.13		1,980.00	167,549.32	33,837.26	328,551.85	197,533.45	
Minnesota.....	532,674.87	205,218.32	327,456.55	12,905.20		1,980.49	157,466.02	32,866.61	139,214.58	261,984.80	
Mississippi.....	639,039.09	273,425.80	365,613.29	35,375.91	19,842.68	1,969.00	181,201.86	35,036.35	103,628.49	159,696.73	
Missouri.....	545,684.88	261,534.66	284,150.22	13,267.10			210,645.26	37,622.30	124,453.49	159,696.73	
Montana.....	318,372.14	104,763.11	233,609.03	24,755.95			51,613.89	23,203.31	77,929.57	135,679.46	
Nebraska.....	388,212.24	157,555.34	230,656.90	13,806.00		1,980.00	108,389.25	28,641.35	98,887.02	118,627.11	13,142.77
Nevada.....	131,174.57	51,924.38	79,250.19	17,310.66			16,862.72	20,602.75	41,779.71	36,771.73	
New Hampshire.....	201,519.73	68,908.43	132,611.30	13,299.55		1,980.00	28,033.64	26,532.51	104,450.00	60,111.30	
New Jersey.....	413,096.44	183,114.36	286,974.70	19,625.66		1,911.25	42,616.21	22,864.62	32,616.21	64,675.93	3,655.73
New Mexico.....	636,504.18	257,457.37	1,379,046.81	10,045.05			208,062.91	37,369.41	614,674.78	719,977.77	44,394.26
New York.....	705,111.27	311,902.23	393,209.04	31,433.59		1,980.00	238,426.37	40,062.27	170,738.78	216,054.97	6,395.29
North Carolina.....	283,489.08	122,146.63	161,342.45	23,545.70		1,500.00	71,683.39	25,417.54	61,324.34	96,734.93	3,283.18
North Dakota.....	904,217.00	291,098.16	613,118.84	10,527.99		1,749.96	239,917.62	38,902.59	365,534.44	247,584.40	
Ohio.....	608,597.09	236,833.24	371,763.85	28,005.42			174,389.77	34,438.05	159,482.86	212,280.99	
Oklahoma.....	348,025.47	243,500.22	22,602.98	22,602.98	4,800.00		53,524.53	23,797.79	152,882.80	86,232.71	4,384.62
Oregon.....	855,242.79	394,087.08	461,155.71	34.58		1,500.00	353,641.38	38,911.12	309,887.71	151,268.00	
Pennsylvania.....	57,291.70	35,663.99	21,627.71	6,843.34			10,977.07	17,843.58	4,661.90	13,178.00	3,787.81

TABLE 25.—Expenditures of funds from all sources for cooperative agricultural extension work in States, Hawaii, and Porto Rico for the year ended June 30, 1930, by sources of funds, and totals for 1915-1929—Continued

State	Grand total	Total Federal funds	Total within the State	Funds from Federal sources				Funds from within State			
				U. S. Department of Agriculture		Federal Clarke-McNary	Federal Smith-Lever	Federal Capper-Ketcham	State and college	County	Farmers' organizations, etc.
				Farmers' cooperative demonstrations	Other						
South Carolina.....	\$501,040.27	\$227,279.26	\$273,761.01	\$30,350.70	\$2,400.00		\$163,451.23	\$32,477.33	\$110,862.85	\$162,898.16	
South Dakota.....	308,085.09	117,730.89	190,354.20	21,108.29	7,500.00		69,037.45	25,185.15	99,798.17	90,556.03	
Tennessee.....	630,960.26	279,047.55	351,912.71	32,210.77		\$1,938.75	200,633.31	36,744.72	242,572.71	109,340.00	
Texas.....	1,161,594.08	461,718.27	689,873.81	51,310.68	6,994.94	1,980.00	357,816.42	50,553.17	256,226.36	418,767.48	\$24,882.97
Utah.....	135,471.85	81,673.58	63,738.27	16,398.96		1,235.36	35,816.87	22,267.45	48,032.12	4,308.95	1,457.20
Vermont.....	175,526.70	77,496.48	98,030.22	17,316.80	1,057.50		36,770.93	22,351.25	33,200.00	53,535.67	
Virginia.....	585,673.53	258,057.12	327,616.41	30,044.40		1,599.96	190,554.95	35,857.81	208,190.68	109,447.39	9,978.34
Washington.....	288,534.09	121,388.99	137,145.10	23,203.80			77,121.21	21,063.98	29,375.43	100,993.12	6,776.55
West Virginia.....	402,754.82	179,978.12	282,776.70	16,508.67		1,980.00	130,873.37	30,616.08	169,776.06	113,000.64	
Wisconsin.....	531,641.25	206,355.44	325,285.81	7,903.25	2,400.00	1,792.50	163,204.06	33,455.63	158,164.83	167,120.98	
Wyoming.....	184,108.50	66,699.75	117,408.75	17,049.99		1,500.00	25,133.15	21,329.11	67,078.75	50,330.00	
Hawaii.....	70,662.55	50,662.55	20,000.00	662.55		1,941.50	27,905.20	20,594.80	20,000.00		
Porto Rico.....	3,888.89	1,941.50	1,947.39						1,947.39		
Total, 1930.....	24,266,064.87	8,732,716.69	15,533,348.18	942,145.44	94,623.83	55,218.21	6,182,049.18	1,458,680.03	7,172,266.60	7,099,140.59	1,261,940.99
1929.....	22,870,026.76	8,412,090.30	14,457,936.46	952,935.37	356,671.43	51,688.37	6,159,777.48	891,017.65	6,533,642.12	6,729,270.85	1,195,023.49
1928.....	20,677,423.66	7,040,447.03	13,636,976.63	979,522.15	131,465.36	50,664.51	5,878,705.01		6,210,848.55	6,232,223.56	1,183,904.82
1927.....	20,147,319.39	6,901,664.21	13,245,655.18	986,993.90	83,081.91	43,251.66	5,878,438.74		5,855,177.85	6,104,682.36	1,195,794.97
1926.....	19,463,728.61	6,885,983.69	12,577,744.92	967,166.73	129,377.72	32,020.34	5,879,418.90		5,766,165.92	5,667,425.56	1,144,153.44
1925.....	19,332,371.40	7,070,330.90	12,262,040.50	962,360.34	228,856.67		5,857,083.89		5,636,721.89	5,628,601.25	1,096,717.36
1924.....	18,082,925.04	7,085,826.81	11,996,198.23	991,900.82	234,320.98		5,859,605.01		5,239,420.54	5,612,556.56	1,144,221.13
1923.....	18,484,845.00	7,107,153.86	11,383,706.58	1,004,729.29	275,532.24		5,820,816.80		5,175,811.94	5,189,974.03	1,017,986.61
1922.....	17,181,751.64	6,727,153.86	10,454,597.78	1,007,263.48	209,540.93		5,510,349.45		4,715,382.34	4,685,415.80	1,053,799.64
1921.....	16,792,248.32	6,434,178.53	10,358,069.79	1,025,083.33	433,046.70		4,974,048.50		4,812,344.83	4,829,366.05	1,029,366.05
1920.....	14,635,079.92	6,434,178.53	8,200,901.39	1,021,081.33	406,020.96		4,464,344.36		3,576,220.91	3,961,663.71	929,739.27
1919.....	14,601,764.75	6,434,178.53	5,262,519.12	2,564,839.70	935,373.64		2,538,828.04		2,487,894.91	2,607,576.89	527,047.32
1918.....	11,302,764.75	6,039,041.38	4,827,009.21	3,900,406.30	507,282.95		2,088,066.29		2,194,421.72	2,078,709.49	553,878.00
1917.....	6,149,619.63	2,719,281.40	3,436,338.23	3,900,406.30	185,893.15		1,575,923.38		1,784,238.47	1,352,852.88	293,256.88
1916.....	4,804,180.94	2,143,485.66	2,660,695.28	900,339.92	165,172.01		1,077,923.73		1,370,218.08	1,042,478.35	307,998.85
1915.....	3,597,235.85	1,485,885.13	2,111,350.72	905,782.00	105,168.40		474,934.73		1,044,270.38	780,331.79	286,748.55

* Prior to 1926, included funds from various other bureaus.

* Includes \$4,598,243.13 emergency funds.

* Includes \$2,949,072.48 emergency funds.

TABLE 26.—*Total expenditures of funds from all sources for cooperative agricultural extension work in States, Hawaii, and Porto Rico for the year ended June 30, 1930, by items of expense, and totals for 1915–1929*

State	Total appropriation	Personal services—salaries and labor	Printing, binding, and cuts for publications	Supplies and materials	Communication service	Transportation of things	Heat, light, water, and power	Equipment	Travel expenses	Miscellaneous
Alabama.....	\$706,137.01	\$575,639.18	\$11,074.73	\$24,007.97	\$13,172.42	\$2,098.55	\$2,742.07	\$17,803.71	\$55,673.04	\$3,925.34
Arizona.....	143,764.44	104,995.76	1,547.23	3,511.46	1,386.55	159.86	93.70	1,189.96	20,291.11	1,583.81
Arkansas.....	577,901.90	511,376.46	1,091.27	10,991.27	2,366.32	433.82		5,568.23	35,002.48	4,084.56
California.....	809,652.13	609,852.00	32,413.40	10,155.05	10,155.05	1,266.51	741.47	10,942.34	129,339.70	8,783.66
Colorado.....	277,428.70	190,315.04	11,753.61	4,748.59	4,748.59	4,748.59	60.15	1,613.42	58,181.92	6,440.47
Connecticut.....	290,868.04	187,309.15	11,858.28	8,408.66	8,408.66	473.08	108.36	5,259.51	53,485.95	17,034.65
Delaware.....	58,811.96	44,128.62	1,370.54	1,871.65	776.40	36.85		850.20	9,728.71	48.99
Florida.....	363,348.23	320,595.76	5,238.69	7,171.25	699.62	299.96	170.43	1,568.08	27,171.61	462.83
Georgia.....	801,700.73	679,154.64	6,385.07	6,385.07	3,123.73	135.16	1,650.00	2,622.48	40,376.16	63,250.50
Idaho.....	1,049,202.97	164,930.80	1,847.35	7,645.17	4,791.56	757.72	191.19	1,137.51	62,146.93	1,274.74
Illinois.....	1,049,059.87	675,420.74	6,915.60	58,713.21	37,995.36	2,370.72	8,503.54	43,275.55	95,799.94	120,064.94
Indiana.....	1,068,976.05	491,812.25	2,669.00	20,810.22	7,213.35	848.87	545.82	3,195.54	82,922.40	12,846.60
Iowa.....	1,068,976.05	711,898.40	31,760.57	45,478.23	35,215.87	7,272.94	4,000.00	9,554.93	160,477.71	62,976.00
Kansas.....	701,962.79	490,632.97	995.39	34,325.86	17,650.24	1,551.65	1,053.00	30,276.64	75,757.63	49,399.71
Kentucky.....	555,887.92	423,189.79	6,784.30	17,760.71	1,760.71	460.80	3,600.00	1,344.01	113,113.62	288.51
Louisiana.....	496,950.25	447,218.65	5,346.18	7,371.91	1,405.68	409.47	7.01	4,629.47	32,283.23	741.38
Maine.....	370,953.41	277,641.51	1,343.22	8,674.04	4,340.71	397.48	1,701.69	3,753.35	39,742.03	704.82
Maryland.....	434,998.00	205,076.79	2,480.84	12,128.87	2,335.79	1,206.14	2,305.00	1,256.78	67,962.63	2,137.49
Massachusetts.....	434,998.00	605,240.27	10,725.45	18,609.44	3,215.09	446.48		1,997.95	165,467.80	1,655.60
Michigan.....	739,672.01	397,939.65	9,496.68	10,634.61	8,296.53	1,044.03	346.47	7,382.99	91,900.59	1,773.34
Minnesota.....	532,674.87	389,803.36	3,153.08	5,532.55	2,075.28	295.03	667.95	1,043.53	98,382.18	3,431.79
Mississippi.....	639,039.09	339,350.60	11,023.52	25,437.95	8,593.26	913.69	305.39	5,601.89	34,784.22	1,164.00
Missouri.....	545,684.88	234,730.58	2,286.82	4,061.34	1,619.70	329.49	963.94	1,169.65	95,005.86	4,552.72
Montana.....	318,372.14	292,252.71	2,064.77	15,967.89	7,993.71	812.04	325.73	8,770.56	54,429.69	11,691.00
Nebraska.....	385,212.24	292,252.71	2,064.77	15,967.89	7,993.71	812.04	325.73	8,770.56	54,429.69	11,691.00
Nevada.....	131,174.57	78,516.02	601.98	5,463.27	2,741.29	510.19	273.73	11,841.40	28,139.93	5,985.14
New Hampshire.....	201,519.73	139,317.98	3,323.41	7,819.83	2,755.94	686.70	700.00	3,278.13	40,337.47	3,294.27
New Jersey.....	413,096.44	307,582.31	6,923.19	20,187.55	5,201.64	351.70	822.77	14,345.79	52,908.67	3,294.27
New Mexico.....	183,114.36	123,004.31	8,083.16	62,569.66	38,315.99	634.56	600.00	2,559.93	46,929.17	4,767.82
New York.....	1,636,604.18	897,638.75	98,863.66	62,569.66	38,315.99	634.56	43,271.01	60,249.37	189,122.02	243,551.33
North Carolina.....	705,111.27	604,928.19	1,250.34	6,328.94	2,127.58	545.04	10,000.00	1,842.63	83,138.87	338.54
North Dakota.....	283,489.08	194,973.60	1,250.34	6,328.94	2,127.58	545.04	10,000.00	1,842.63	83,138.87	338.54
Ohio.....	908,697.09	697,469.76	17,474.38	22,609.25	9,259.64	528.46	260.76	8,388.30	143,000.72	383.71
Oklahoma.....	604,217.00	545,164.27	2,948.05	9,650.08	3,259.63	245.33	54.26	4,109.52	43,870.08	5,094.92
Oregon.....	348,925.47	240,075.57	2,368.32	9,650.08	7,543.98	833.34	1,790.29	2,231.13	62,271.24	2,230.13
Pennsylvania.....	855,242.79	584,256.41	1,290.14	14,360.61	13,388.77	946.18		1,623.66	160,420.94	73,103.42
Rhode Island.....	37,231.70	38,473.26	273.50	2,858.19	309.96	57.01		1,338.39	9,073.97	4,962.40
South Carolina.....	501,040.27	434,707.58	5,875.17	9,828.70	5,095.30	284.47	621.28	1,687.27	37,988.10	1,285.73
South Dakota.....	308,085.09	228,220.56	2,294.08	11,873.41	4,880.05	568.98	209.62	1,323.70	57,428.96	4,962.40
Tennessee.....	300,960.26	555,190.33	10,560.53	13,177.36	2,664.90	604.04	987.93	3,608.92	41,227.43	2,989.26
Texas.....	1,161,994.08	1,084,790.33	5,377.36	6,891.85	2,660.26	547.63		1,626.92	56,582.06	117.07

TABLE 26.—Total expenditures of funds from all sources for cooperative agricultural extension work in States, Hawaii, and Porto Rico for the year ended June 30, 1930, by items of expense, and totals for 1915-1929—Continued

State	Total approp- riation	Personal serv- ices—salaries and labor	Printing, binding, and cuts for pub- lications	Supplies and materials	Communica- tion service	Transporta- tion of things	Heat, light, water, and power	Equipment	Travel expenses	Miscellane- ous
Utah.....	\$135,471.85	\$111,998.04	\$812.40	\$2,638.40	\$636.19	\$146.92	-----	\$1,231.57	\$15,842.82	\$2,145.51
Vermont.....	175,526.70	121,387.40	196.53	10,238.53	3,167.13	545.87	-----	2,096.79	31,211.73	5,987.29
Virginia.....	555,673.53	475,625.81	8,566.42	10,927.66	2,659.66	749.91	190.96	3,169.32	81,841.36	2,142.43
Washington.....	288,534.09	194,995.66	4,516.81	15,537.69	3,264.93	594.30	-----	3,005.99	35,565.69	1,043.02
West Virginia.....	462,754.82	378,111.73	5,077.90	29,068.65	5,412.06	886.01	2,505.15	6,333.88	35,015.49	1,344.85
Wisconsin.....	531,641.25	408,753.13	6,749.89	5,718.57	3,668.12	122.69	-----	-----	106,584.95	43.90
Wyoming.....	184,108.50	124,458.83	1,670.05	1,915.73	579.28	169.80	-----	342.86	54,778.40	193.55
Hawaii.....	70,662.55	52,379.21	2,234.79	2,150.37	465.79	111.07	-----	2,418.07	10,330.15	573.10
Porto Rico.....	3,888.89	3,349.50	42.50	75.46	-----	-----	-----	170.62	250.81	-----
Total, 1930.....	24,265,064.87	18,452,348.84	337,789.84	688,502.17	319,015.28	39,901.52	94,528.10	314,177.67	3,263,502.69	756,298.76
1929.....	22,870,026.76	17,035,051.12	342,182.63	640,033.93	297,314.16	40,943.53	88,198.90	384,080.53	3,451,340.08	590,881.28
1928.....	20,677,423.66	15,046,449.16	296,136.16	537,921.00	269,407.27	38,873.89	90,173.92	265,727.18	3,017,628.45	515,100.63
1927.....	20,147,319.39	15,106,156.34	308,999.13	547,306.70	278,925.49	34,512.35	86,308.32	235,941.92	3,045,401.81	503,767.33
1926.....	19,463,728.61	14,023,445.77	332,887.97	523,105.44	270,253.81	32,076.21	77,008.93	240,933.31	2,899,159.58	464,852.59
1925.....	19,332,371.40	14,376,987.22	317,825.82	515,783.58	255,634.14	33,419.12	85,051.59	279,476.73	3,000,956.41	467,236.79
1924.....	18,082,025.04	13,960,024.41	344,036.52	771,311.06	233,704.70	27,215.82	63,155.12	176,912.37	3,147,711.34	357,953.70
1923.....	18,484,845.00	13,669,718.39	336,906.94	477,957.00	194,642.98	1	54,900.21	148,038.36	3,031,252.99	545,861.12
1922.....	17,181,751.64	12,740,999.28	385,859.62	410,592.62	186,502.01	-----	47,197.29	129,259.56	2,765,227.90	506,053.36
1921.....	16,792,248.32	12,416,878.29	382,034.06	516,051.82	195,275.08	-----	48,735.14	140,983.36	2,873,523.01	218,767.56
1920.....	14,658,079.92	10,481,790.44	308,629.24	433,337.62	137,230.47	-----	36,471.25	134,720.51	2,807,758.73	318,101.66
1919.....	14,661,560.50	10,649,803.53	263,371.74	493,138.35	133,351.26	-----	19,574.36	185,407.27	2,735,151.37	187,762.77
1918.....	11,302,764.75	8,335,805.69	190,267.35	417,264.23	127,128.31	-----	6,214.88	216,040.27	1,830,764.70	167,247.60
1917.....	6,149,619.63	4,490,900.05	144,777.26	250,752.18	68,330.02	-----	8,842.21	87,223.27	1,023,405.63	98,016.34
1916.....	4,804,180.94	3,514,061.85	98,850.56	176,793.16	48,709.30	-----	4,842.21	95,182.98	849,259.37	76,481.51
1915.....	3,597,235.85	2,686,923.95	72,090.72	105,526.62	37,437.90	-----	9,614.79	63,084.01	603,432.74	19,125.12

1 Prior to 1923, transportation of things was included in communication service.

TABLE 27.—Expenditures of funds from all sources for cooperative agricultural extension work in States, Hawaii, and Porto Rico for the year ended June 30, 1930, by projects, and totals for 1915-1929

State	Total	Adminis- tration	Printing and dis- tribution of publi- cations	County agent work	Home demonstra- tion work	Boys' and girls' club work	Home- econom- ics spe- cialists	Exten- sion schools	Animal hus- bandry	Poultry	Dairying	Animal diseases	Agron- omy	Foods and nu- trition	Child care and training
Ala.	\$706,137.01	\$26,872.33	\$11,742.67	\$221,290.70	\$164,799.09	\$10,904.10		\$4,538.29	\$6,153.46	\$16,438.58	\$9,178.47		\$5,068.23	\$4,730.42	
Ariz.	143,764.44	13,995.56	1,547.23	76,493.12	32,070.28	4,356.43		5,712.87	5,830.63	2,449.46	2,284.06		4,066.86		
Ark.	577,901.90	18,841.42	7,508.76	293,298.69	196,883.04	6,383.91		5,712.87	4,302.11	5,712.21	5,063.90		5,594.86	\$7,004.64	
Calif.	803,654.13	12,557.10		485,989.41	167,533.79	26,375.00		4,396.10	7,856.43	5,795.10	6,295.10		5,396.10	6,195.10	
Colo.	277,428.70	19,086.29	3,204.69	154,192.43	30,846.75	16,859.65		4,396.10	7,856.43	8,480.80	5,113.19		5,292.51	4,201.74	
Conn.	290,868.04	18,686.29	5,363.26	66,000.49	44,583.69	60,704.65		980.99	4,985.57	13,182.12	15,320.76		5,594.06	4,478.36	
Del.	58,811.96	9,504.00	1,372.54	15,972.90	13,718.52	12,451.80		2,923.57	10,400.81	11,915.47	5,125.83			3,745.09	
Fla.	363,348.23	7,316.38	4,553.53	176,154.49	134,545.93	5,819.79		2,923.57	10,400.81	11,915.47	5,125.83			3,745.09	
Ga.	801,700.73	20,419.44	1,666.19	351,380.47	205,312.12	17,424.51		2,229.89	14,158.29	2,901.64	6,808.29		24,132.85	5,977.42	83,806.38
Idaho.	244,202.97	11,545.96	3,355.52	753,455.83	126,203.46	43,502.57		2,229.89	14,158.29	2,901.64	6,808.29		26,258.13		
Ill.	1,049,936.87	27,490.12	2,669.00	348,857.94	26,413.42	72,366.10		46,532.45	7,753.79	10,242.35	14,545.42		12,724.07	6,257.28	3,360.45
Ind.	622,976.07	27,490.12	3,355.52	753,455.83	126,203.46	43,502.57		46,532.45	7,753.79	10,242.35	14,545.42		12,724.07	6,257.28	3,360.45
Iowa.	1,068,632.65	62,991.87	3,098.57	655,413.15	54,649.69	33,839.94		31,673.98	16,569.48	9,314.14	36,539.17		17,661.34	11,120.04	473.87
Kans.	400,170.48	25,717.72	3,607.18	32,990.98	16,569.48	9,314.14		31,673.98	16,569.48	9,314.14	36,539.17		17,661.34	11,120.04	473.87
Ky.	701,962.79	25,717.72	3,607.18	32,990.98	16,569.48	9,314.14		31,673.98	16,569.48	9,314.14	36,539.17		17,661.34	11,120.04	473.87
La.	555,887.92	30,945.42	2,881.48	249,922.45	138,877.74	12,002.11		7,848.84	14,597.14	9,307.58	4,907.27		12,793.32	8,291.28	
Le.	496,950.25	30,945.42	2,881.48	249,922.45	138,877.74	12,002.11		7,848.84	14,597.14	9,307.58	4,907.27		12,793.32	8,291.28	
Me.	196,240.03	10,317.75	1,299.10	70,552.07	51,356.08	26,847.14		680.74	3,874.40	3,572.22	3,815.86		2,227.73	3,121.09	
Md.	370,958.01	17,784.17	3,934.55	136,553.31	101,586.04	8,923.42		4,235.96	4,744.28	5,362.58	4,354.60		5,068.11	3,953.05	3,901.87
Mass.	434,598.01	18,774.62	2,444.09	109,983.42	93,893.22	127,402.00		4,235.96	4,744.28	5,362.58	4,354.60		5,068.11	3,953.05	3,901.87
Mich.	738,672.01	13,257.88	1,306.21	353,302.62	32,921.88	76,234.82		558.51	12,703.75	19,622.11	22,944.88		51,257.53	9,577.41	4,231.20
Minn.	532,674.87	24,566.20	9,364.03	304,559.33	38,636.23	60,265.60		558.51	12,703.75	19,622.11	22,944.88		51,257.53	9,577.41	4,231.20
Miss.	639,039.09	25,062.68	3,153.08	300,180.65	221,751.66	18,874.21		750.59	14,808.14	10,490.01	11,238.32		22,281.43	3,846.40	
Mo.	545,634.88	14,546.14	13,710.39	311,880.51	61,841.76	20,801.01		2,221.06	10,728.67	7,894.25	8,314.88		6,872.92	4,391.27	
Mont.	318,372.14	15,935.61	2,035.01	182,773.17	44,671.84	9,441.02		2,221.06	10,728.67	7,894.25	8,314.88		6,872.92	4,391.27	
Nebr.	388,212.24	17,773.30	2,364.36	213,314.16	28,654.44	23,491.01		2,221.06	10,728.67	7,894.25	8,314.88		6,872.92	4,391.27	
Nev.	131,174.57	11,740.25	592.98	73,410.79	40,910.35	57,446.02		1,364.69		1,048.05	1,972.15		9,572.09	6,601.75	
N.H.	201,519.73	12,852.61	1,937.36	53,906.46	38,294.48	60,406.06		1,364.69		1,048.05	1,972.15		9,572.09	6,601.75	
N.J.	413,066.44	16,991.01	6,014.52	145,534.74	90,041.08	60,406.06		1,364.69		1,048.05	1,972.15		9,572.09	6,601.75	
N.Mex.	183,114.36	13,516.76	2,098.87	98,298.18	44,972.55	153,784.97		49,332.51	5,286.27	12,766.05	12,354.05		5,617.56	5,495.67	4,942.84
N.Y.	636,504.18	235,452.16	8,863.16	503,714.28	264,408.79	5,185.43		49,332.51	5,286.27	12,766.05	12,354.05		5,617.56	5,495.67	4,942.84
N.C.	705,111.27	19,128.50	6,449.03	367,633.52	200,665.62	5,185.43		49,332.51	5,286.27	12,766.05	12,354.05		5,617.56	5,495.67	4,942.84
N.Dak.	283,489.08	20,728.97	2,020.96	158,838.84	25,538.73	11,301.24		49,332.51	5,286.27	12,766.05	12,354.05		5,617.56	5,495.67	4,942.84
Ohio	904,217.00	44,845.07	20,203.36	368,448.85	102,631.92	72,760.16		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	
Okl.	698,597.09	24,507.14	2,915.38	289,054.78	182,943.41	14,753.91		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	
Oreg.	348,025.47	34,203.88	1,259.40	181,745.53	22,903.18	48,491.06		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	
Pa.	855,242.79	68,696.84	1,284.00	398,094.39	133,690.01	25,415.09		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	
R.I.	37,291.70	3,328.39	1,121.30	13,374.76	13,374.76	13,374.76		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	
S.C.	501,040.27	27,176.00	5,875.17	229,267.73	142,733.01	9,660.02		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	
S.Dak.	13,447.67	5,827.82	734.50	150,030.21	47,008.83	32,956.63		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	
Tenn.	630,960.26	37,261.61	10,840.53	323,375.76	158,404.41	11,261.81		45,338.47	4,923.23	9,051.80	2,994.92		28,974.76	3,612.51	

TABLE 27.—Expenditures of funds from all sources for cooperative agricultural extension work in States, Hawaii, and Porto Rico for the year ended June 30, 1930, by projects, and totals for 1915-1929—Continued

State	Total	Adminis- tration	Printing and dis- tribution of pub- lications	County agent work	Home demonstra- tion work	Boys' and girls' club work	Home- econom- ics spe- cialists	Exten- sion schools	Animal hus- bandry	Poultry	Dairying	Animal diseases	Agro- nomy	Foods and nu- trition	Child care and training
Tex.	\$1,161,594.08	\$32,052.35	\$5,377.36	\$647,706.10	\$386,906.97	\$50.00			\$11,847.04	\$5,580.81	\$5,199.79		\$5,737.41	\$3,613.34	
Utah	135,471.85	16,633.98	812.40	66,233.91	18,942.04	3,947.03			2,806.06	1,980.07	1,111.48		4,069.93	3,119.41	
Vt.	175,526.70	12,404.98	523.01	51,600.13	42,053.12	46,509.69			5,337.09	13,058.43	4,964.21		7,038.17	4,769.76	
Va.	585,673.53	30,944.74	12,549.44	298,678.30	330,820.28	9,810.27			9,543.59	13,058.43	18,116.61	\$4,342.02	4,426.61	3,463.99	
Wash.	258,534.09	468,754.82	4,300.73	144,585.65	33,829.38	24,251.59			2,659.15	4,740.85	5.80		5,200.44	7,955.77	
W. Va.	627,734.82	27,281.57	11,118.26	159,918.65	71,690.39	110,442.41			8,074.31	12,027.44	24,287.63		20,999.03	7,955.77	
Wis.	531,641.25	16,609.68	12,706.69	271,345.33	23,536.74	45,977.44		\$17,565.48	11,065.28	10,027.44	24,287.63		4,485.21	3,986.58	
Wyo.	184,108.50	15,399.66	1,512.55	95,767.62	35,842.86	7,014.73			3,855.32	4,680.02	2,706.52				
Hawaii	70,602.55	10,333.57	2,294.88	23,906.96	25,706.04				4,801.10						
P. R.	3,888.89														
Total:	24,206,064.87	1,269,097.46	350,373.66	11,877,946.25	4,494,923.83	1,535,225.00	\$40,623.21	243,694.77	391,635.93	400,192.47	450,245.19	47,797.10	476,428.37	220,987.59	\$33,999.43
1929	22,870,026.76	1,128,404.06	351,405.12	11,279,965.61	4,120,553.97	1,400,350.13	47,831.56	237,137.84	388,537.55	366,053.25	417,105.39	393,525.56	451,252.19	209,793.47	16,640.92
1928	20,677,423.66	1,104,828.92	281,366.44	10,428,075.46	3,473,385.97	1,213,207.16	88,698.02	229,514.13	409,316.08	348,698.64	356,780.70	36,688.66	437,965.97	194,941.97	
1927	20,147,319.39	1,064,771.80	367,432.37	10,417,472.81	3,230,811.22	1,095,659.16	89,253.61	244,949.38	417,323.02	322,016.92	337,172.79	30,799.85	403,985.27	187,264.08	
1926	19,463,748.61	1,084,480.88	306,746.12	10,110,852.06	3,142,681.57	1,069,465.82	94,996.20	258,241.06	345,716.18	313,069.22	333,597.75	30,424.76	399,490.81	187,897.17	
1925	19,332,371.40	1,329,491.32	323,622.11	9,936,517.45	2,998,862.25	1,059,714.37	203,565.07	261,868.23	368,775.08	281,094.33	383,405.85	35,842.58	413,403.27	153,450.45	
1924	19,082,025.04	1,021,783.43	389,321.61	9,999,271.48	2,831,269.37	991,490.45	575,250.46	246,408.66	355,517.40	284,732.32	395,207.26	36,761.09	417,858.06		
1923	18,484,845.00	1,226,809.21	332,987.35	9,625,817.43	2,790,419.11	991,779.50	502,968.18	254,388.90	338,874.66	270,060.32	309,724.59	54,798.23	388,279.58		
1922	17,181,731.64	1,159,074.59	408,983.22	8,946,340.45	2,400,789.74	1,054,388.85	470,378.09	219,213.29	334,436.03	241,417.41	289,773.00	40,492.07	350,695.55		
1921	16,792,218.32	1,147,756.06	382,034.06	8,911,965.32	2,388,473.21	923,982.19	300,146.47	243,483.54	300,270.51	209,451.02	323,182.77	36,532.87	281,547.94		
1920	14,658,079.92	997,051.57	308,629.24	7,665,170.77	2,177,024.52	883,015.86	332,415.38	239,453.36	251,141.57	151,161.93	276,917.62	303,200.89	218,019.26		
1919	14,661,560.50	930,658.24	263,616.98	7,124,500.90	2,889,210.50	921,621.38			221,966.97	380,168.56	199,441.09	280,756.98	71,678.74	170,534.71	
1918	11,302,704.75	754,175.86	207,478.98	5,604,962.72	2,226,227.97	669,668.18			237,364.78	309,270.72	70,402.84	332,852.55	31,777.11	153,211.24	
1917	6,149,613.63	512,801.54	137,647.87	3,008,940.92	741,673.89	319,556.91			321,079.76	162,063.74	59,498.54	208,966.83	94,215.50	105,529.57	
1916	4,864,180.94	445,243.67	99,779.68	2,411,539.81	519,806.99	231,227.10			322,726.80	131,937.90	47,328.40	172,557.69	21,936.02	77,559.06	
1915	3,498,815.35	295,308.48	71,597.65	1,902,230.51	319,822.50	102,448.27			359,173.64	42,448.08	19,373.14	106,098.08	4,563.64	20,912.81	

State	Clothing	Home management	Horticulture	Botany and plant pathology	Entomology, apiculture, ornithology	Rodent pests	Forestry	Agricultural engineering	Farm management	Rural organization	Marketing	Exhibits and fairs	Information	Miscellaneous specialties
Alabama.....	\$4, 568.81	\$4, 426.75	\$8, 864.17		\$4, 125.27		\$3, 960.00	\$12, 045.72			\$13, 193.67	\$530.91	\$71, 082.75	\$1, 017.62
Arizona.....							3, 973.89				4, 443.07	670.81	8, 187.91	
Arkansas.....	1, 555.78	3, 444.83	3, 000.01				5, 386.37	11, 496.10	\$10, 244.99		12, 496.06	6, 295.10	7, 217.20	9, 895.10
California.....	5, 102.01	5, 095.40	11, 295.10					6, 195.11			4, 617.34		4, 850.00	2, 656.25
Colorado.....	3, 207.12	4, 721.37	3, 464.19				2, 401.70	2, 678.52	6, 503.35		7, 325.71			230.00
Connecticut.....	4, 538.29	4, 703.00	10, 756.58		2, 362.58									
Delaware.....				\$265.48	790.17									
Florida.....			959.06		959.06		6, 854.42	9, 862.08	3, 673.91		8, 937.19	3, 122.51	2, 948.26	
Georgia.....	3, 969.51	3, 462.26	15, 111.83				8, 900.29		283.11				13, 771.38	63, 250.00
Illinois.....	4, 533.12		4, 794.17		2, 105.07	\$4, 723.66	2, 999.88	4, 702.03	10, 240.53	\$1, 395.77	906.06		3, 783.12	
Indiana.....	3, 686.53	6, 573.91	8, 388.99		114.78		308.25	2, 647.74	8, 909.93				2, 738.01	
Iowa.....	2, 522.04	6, 425.72	9, 108.67	8, 198.04			4, 005.43	3, 836.35	10, 185.14	3, 257.14	34, 733.16	3, 890.13	10, 815.17	
Kansas.....	11, 208.71	20, 757.08	18, 498.84	4, 440.54	13, 633.43	181.14		10, 932.43	4, 488.33	4, 027.77	3, 657.43		5, 895.77	
Kentucky.....	8, 783.32	3, 466.16	6, 440.69	4, 249.04	5, 335.92			5, 986.96	4, 951.32		6, 433.50		4, 539.42	
Kentucky.....	7, 328.54		9, 557.52				3, 792.08	3, 394.91		3, 578.32	2, 899.74		5, 883.44	
Louisiana.....	4, 162.12		7, 534.83		6, 333.39		3, 211.01		5, 796.87				4, 932.63	
Maine.....	3, 318.45	3, 163.57	12, 471.76	10, 075.25	20, 244.84		3, 909.00			3, 970.00	9, 081.93		5, 306.29	
Maryland.....	3, 455.46						3, 211.01						5, 084.95	
Massachusetts.....	5, 145.62	4, 504.61	16, 607.89	2, 011.52			4, 026.44	27.72	5, 889.43		5, 514.67	2, 162.06	21, 059.23	
Michigan.....	7, 494.24	14, 194.58	27, 199.57	2, 012.51	2, 322.51		5, 283.81	27, 844.04	5, 942.46		16, 298.64		7, 881.12	
Minnesota.....	7, 411.02	3, 813.15	107.14	4, 428.72	1, 674.25		4, 645.30		9, 570.21	3, 300.00	2, 522.97		3, 191.75	
Mississippi.....		7, 336.21	9, 088.78				4, 688.00	5, 337.55	5, 206.74	5, 227.40	11, 778.67		9, 538.98	
Missouri.....	10, 997.37	7, 490.78	4, 520.43		2, 213.30			6, 786.74		5, 371.43	5, 090.33		4, 039.19	2, 178.00
Montana.....	4, 077.43	3, 548.42	5, 045.58	1, 200.00				497.31	12, 017.03			269.68	8, 789.89	
Nebraska.....	5, 361.42	6, 843.11	4, 310.72		1, 965.39		4, 760.74	11, 755.84	7, 951.83	5, 374.25	1, 490.14		1, 500.00	
Nevada.....									4, 655.77				1, 610.00	
New Hampshire.....	3, 089.38	3, 939.73	4, 224.05				4, 323.73		7, 969.06				10, 178.75	
New Jersey.....	3, 866.37	3, 376.96	15, 980.65				5, 894.22	3, 676.85					4, 377.44	
New Mexico.....			1, 238.78						1, 518.03				27, 323.78	4, 500.00
New York.....	11, 662.68	17, 520.81	29, 339.25	22, 370.88	11, 910.64		7, 899.98	16, 404.84	23, 554.53	9, 079.14	1, 000.00		8, 441.75	1, 473.97
North Carolina.....	3, 653.59	3, 599.52	8, 458.97	3, 675.26	8, 379.56		5, 093.71	3, 672.72			1, 629.85		4, 980.01	
North Dakota.....	11, 667.67	8, 637.31					3, 000.00	3, 455.08	7, 247.80		13, 218.52		17, 050.60	
Ohio.....	12, 225.89	8, 833.20	31, 515.70	7, 819.92	13, 697.91		3, 741.49	13, 891.00	24, 816.82	5, 510.17	3, 547.33		7, 791.95	
Oklahoma.....	3, 601.68	3, 170.49	8, 187.68		9, 440.65			6, 664.95	2, 170.29		15, 478.18		10, 505.34	
Oregon.....		5, 243.13	5, 243.13			2, 610.82		40.50	1, 556.31		10, 622.79		4, 000.00	1, 251.51
Pennsylvania.....	18, 616.51		24, 538.59	17, 017.53	21, 337.60		10, 875.11		11, 133.89	5, 311.40				
Rhode Island.....			1, 796.79								13, 476.41		7, 177.87	
South Carolina.....			7, 966.91	1, 591.03	7, 527.44			1, 892.47	5, 370.23				3, 531.07	
South Dakota.....	3, 478.06		3, 000.00		2, 167.42				10, 296.50		5, 285.93		4, 200.00	
Tennessee.....	1, 907.07	1, 907.06	5, 302.42				4, 390.03							

TABLE 27.—Expenditures of funds from all sources for cooperative agricultural extension work in States, Hawaii, and Porto Rico for the year ended June 30, 1930, by projects, and totals for 1915-1929—Continued

State	Clothing	Home management	Horticulture	Botany and plant pathology	Entomology, apiculture, ornithology	Rodent pests	Forestry	Agricultural engineering	Farm management	Rural organization	Marketing	Exhibits and fairs	Information	Miscellaneous specialists
Texas.....	\$4,608.12	\$8,691.98	\$5,822.35		\$5,435.11		\$3,960.00	\$5,661.22		\$9,330.07			\$14,014.06	\$5,851.15
Utah.....	3,326.58	811.11					2,470.72						250.00	
Vermont.....		3,766.18	898.95				38.10		4,178.04					
Virginia.....		2,492.38	15,009.97				4,158.31	11,497.06	3,570.22	5,512.17	\$6,994.15		3,160.00	6,776.55
Washington.....	3,847.86	3,191.78					4,624.24		1,652.70		1,265.16		1,400.00	8,330.38
West Virginia.....		22,187.21		\$295.67			7,820.03	4,581.13	1,681.16	11,240.51	10,160.56		5,350.00	
Wisconsin.....	10,522.84	7,339.54	10,722.12	7,280.49			1,573.00		5,698.03					
Wyoming.....	4,826.17	2,143.66					3,600.00		222.00					
Hawaii.....						\$90.00	3,888.89							
Porto Rico.....														
Total, 1930.....	213,407.38	191,773.64	406,934.30	97,890.94	144,076.29	7,605.62	145,660.00	193,270.46	236,353.27	77,860.54	243,600.06	\$16,941.20	351,309.78	107,410.53
1929.....	207,428.86	159,947.24	403,038.25	97,505.16	138,811.77	11,120.31	132,198.86	224,054.27	201,869.58	65,241.47	230,684.48	18,747.26	358,461.40	132,661.46
1928.....	201,927.94	111,397.12	351,738.32	98,896.25	127,880.58	7,238.75	127,658.44	171,075.62	177,215.46	64,264.25	216,306.98	22,998.56	233,881.30	161,525.97
1927.....	205,573.74	108,726.04	357,276.69	93,007.15	121,702.18	7,406.84	115,836.77	158,365.17	178,545.66	69,182.30	172,233.35	37,105.50	154,675.85	155,790.03
1926.....	195,243.18	80,396.21	339,565.75	101,133.48	112,838.27	6,358.05	82,537.27	159,051.02	161,629.62	65,695.89	160,364.10	41,539.07	54,239.87	105,427.43
1925.....	183,231.83	69,871.68	317,171.49	101,697.38	104,265.73	144,785.47	30,918.78	155,021.08	169,453.91	64,422.16	169,131.52	22,299.87	45,968.20	130,818.83
1924.....				95,242.00	106,905.73	143,737.33	18,928.99	167,832.95	156,455.94	30,843.31	177,435.75	24,888.34	13,070.96	86,369.09
1923.....	315,353.61	84,167.35	316,237.49	84,167.35	111,120.36	176,222.78	14,187.56	177,600.66	163,830.70	37,049.51	171,271.52	18,521.48		68,328.25
1922.....	272,175.98	106,683.99	272,175.98	106,683.99	103,562.22	154,067.62	13,201.60	128,178.32	152,623.81	21,318.83	204,185.86	10,311.31		99,549.81
1921.....	241,885.75	246,405.00	241,885.75	246,405.00	98,490.86	158,167.12	10,936.54	124,742.98	146,080.43	22,518.19	179,620.88	23,245.03		12,071.76
1920.....	160,600.55	160,600.55	160,600.55	160,600.55	88,679.73	129,141.12	10,694.57	125,161.36	116,381.31	30,025.75	163,927.62	20,429.41		26,004.41
1919.....	163,788.79	286,997.69	112,474.45	112,474.45	151,373.85	58,670.91	9,409.45	97,295.29	125,614.03	49,575.14	104,268.49	13,159.98		27,388.93
1918.....	125,604.52	61,591.37	100,753.02	82,396.15	14,826.22	16,435.68	5,099.82	64,517.11	102,302.00	42,132.51	50,237.47	12,482.49		27,224.06
1917.....	84,009.57	79,745.13	14,014.12	14,014.12	8,510.74		50,600.78	102,033.20	86,690.26	39,417.36	20,403.57	12,650.06		58,813.72
1916.....							3,638.84	36,680.32	88,690.36	51,531.27	2,298.60	14,019.21		78,628.28
1915.....							3,965.44	13,041.00		5,000.34				120,027.03



FEDERAL HORTICULTURAL BOARD

SEE

PLANT QUARANTINE AND CONTROL ADMINISTRATION



REPORT OF THE CHIEF OF THE FOOD AND DRUG ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOOD AND DRUG ADMINISTRATION,
Washington, D. C., August 29, 1931.

SIR: I submit herewith the report of the Food and Drug Administration for the fiscal year ended June 30, 1931.

Respectfully,

W. G. CAMPBELL, *Chief.*

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The Food and Drug Administration is a separate and distinct bureau of the Department of Agriculture, charged with the duty of enforcing the food and drugs act, the insecticide act, the tea act, the naval stores act, the import milk act, and the caustic poison act.

The independent-bureau status of the Food and Drug Administration is emphasized because it has become apparent that in some quarters a mistaken idea prevails that analytical work incident to the enforcement of these various laws is performed by another bureau of the department, administrative details alone being centered in the Food and Drug Administration. A natural inference from such a misunderstanding would be that the regulatory operations are subject to divided control, a situation obviously conducive to bad administration.

In this report the activities of the Food and Drug Administration, under all the laws assigned to it for enforcement, are briefly reviewed. Because the food and drugs act is the most important of these six laws, and particularly because June 30, 1931, marks the first quarter of a century of its enforcement, especial attention is given to this statute. Certain weaknesses in the law, which have become apparent as the result of 25 years' experience, are pointed out, and recommendations made for their correction.

TWENTY-FIFTH ANNIVERSARY OF THE FOOD AND DRUGS ACT

The Federal food and drugs act was enacted on June 30, 1906, and became operative January 1, 1907. In general it has proved itself an effective instrument for carrying out the purpose of Congress. Born of a definite public necessity, the law continues to be actively enforced because that necessity still exists. This act, drawn up by the late

Harvey W. Wiley and carried through Congress on a wave of popular approval, which he was largely instrumental in bringing into being, provides in brief "for preventing the manufacture, sale, or transportation of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and for regulating interstate traffic therein."

The quarter century since the passage of the food and drugs act has seen some of the most important developments in the history of food and nutrition. Scientific discoveries relating to the composition and nutritive value of foods have been made which could not have been foreseen when the measure was originally framed. Stimulated unmistakably by the existence of this statute, pioneer work in the commercial preparation and preservation of food has made possible material and beneficial reforms in the methods of food industries. At the same time and undoubtedly, in part at least, because of the progress in the science of nutrition and improvements in the methods of food manufacture, the dietary habits of the American people have undergone remarkable changes during this 25-year period. Progress of an equally notable kind in the science of medicine has brought new products within the purview of the law and new problems of enforcement.

The initial purposes of the food and drugs act—(1) to insure the purity of foods and drugs and (2) to protect consumers from economic fraud—have not been altered. While there have been changes in regulatory procedure resulting from more extensive experience in enforcement guided by enlightening court decisions, enforcing officials are concerned now as they were 25 years ago with removing from interstate commerce and from import and export channels products found to be in violation of the law, and prosecuting violators of the statute. More than 18,000 regulatory actions have been instituted. Notwithstanding the great improvement in the quality of foods and drugs, there is still, as in every industry, a minority of operators who, through carelessness or deliberation, are still producing adulterated and misbranded products. Continued vigilance is necessary, therefore, to protect consumers and to prevent the establishment of demoralizing trade conditions. The Food and Drug Administration plans no change during the coming year in its administrative policy, but, so far as its appropriations permit, intends to continue its activity covering the entire vast and growing field of food and drug manufacture and importation.

During the quarter-century period, minor elements of the food and drug industries, seeing in the measure an obstacle to profitable operations which could not be squared with the strict requirements of the statute, have made repeated efforts to weaken the law by amendatory legislation. It is significant, however, that not one of these attempts to influence Congress has been successful. Every amendment to the food and drugs act which has passed Congress since June 30, 1906, has strengthened its provisions and given more protection to the ultimate consumer. The first amendment, approved August 23, 1912 (37 Stat. 416), commonly known as the Sherley amendment, was designed to remedy a defect pointed out by the Supreme Court, and applied to the branding of proprietary medicines. The second amendment, approved March 3, 1913 (37 Stat. 732), imposed a requirement that definite information regarding the

quantity of food in package form appear on the label for the benefit of food consumers. An amendment, approved July 24, 1919 (41 Stat. 271), amplified the last-named amendment by applying its provisions to wrapped meats. Finally, on July 8, 1930, the McNary-Mapes amendment, otherwise known as the canners' bill, was approved. Other incidental amendments to the law, enacted March 4, 1913, and January 18, 1927, made no change in its fundamental provisions but merely provided for minor changes in wording made necessary by governmental reorganization.

RECOMMENDATIONS FOR STRENGTHENING AMENDMENTS

While attempts to weaken the act by legislation have been unsuccessful and while in general the broad terms of the measure have been remarkably effective, the experiences of the past 25 years have clearly shown that the measure in its present form does not insure all of those safeguards to the American consumer that its framers presumably intended. The Supreme Court, in its last decision interpretative of the food and drugs act delivered on June 2, 1924, in the case of the *United States v. Ninety-five Barrels, More or Less, Alleged Apple Cider Vinegar*,¹ summed up the pertinent requirements of the law in this particular case, in these words:

The statute is plain and direct. Its comprehensive terms condemn every statement, design, and device which may mislead or deceive. Deception may result from the use of statements not technically false or which may be literally true. The aim of the statute is to prevent that resulting from indirection and ambiguity, as well as from statements which are false. It is not difficult to choose statements, designs, and devices which will not deceive. Those which are ambiguous and liable to mislead should be read favorably to the accomplishment of the purpose of the act. The statute applies to food, and the ingredients and substances contained therein. It was enacted to enable purchasers to buy food for what it really is.

Further in the same decision the Supreme Court declared: "If an article is not the identical thing that the brand indicates it to be, it is misbranded." In the light of this very clear statement of the judgment of the highest tribunal that the food and drugs act "enjoins truth," it is the belief of the Food and Drug Administration that district and circuit court decisions adverse to the Government on questions of interpretation should be carried to the Supreme Court for final decision. The Food and Drug Administration has consistently adhered to this policy and will continue to urge this course in all instances where legal obstacles do not intervene.

During the past year a case under the food and drugs act, known generally as the Bred Spred case, was brought to a legal conclusion by a decision by the Circuit Court of Appeals, for the Eighth Circuit, adverse to the Government. The product in question was an article resembling a fruit preserve but consisting essentially of sugar, fruit pectin, fruit acid, water, and a materially smaller amount of fruit than a standard fruit preserve. Though deficient in the fruit ingredient which gives characteristic value to preserves, and cheaper to manufacture, it so closely resembled genuine standard fruit preserves as to deceive the average purchaser. It was labeled with a dis-

¹ *United States v. Ninety-Five Barrels, More or Less, Alleged Apple Cider Vinegar*. 44 S. Ct. 37, 263 U. S. 695, 68 L. Ed. 510; also 265 U. S. 438, 68 L. Ed. 1094.

tinctive name "Bred Spred," but investigation revealed that it was frequently retailed as a fruit preserve. The Food and Drug Administration considered it an imitation fruit preserve. The statute distinctly holds an article of food to be misbranded "if it be an imitation of or offered for sale under the distinctive name of another article." Relying upon this provision of the law, the department proceeded against this product. It believed it had convincing evidence to show that it was inferior to standard fruit preserves, that it represented a cheat from the public standpoint, and as a competitor of standard articles had brought about a condition of trade demoralization. Without attempting to review the somewhat complicated history of the litigation surrounding this case, it seems evident that the decision adverse to the Government finally rendered by the circuit court of appeals was in large measure grounded on the proviso in section 8 of the act, paragraph 4, in the case of food, which exempts from a charge of adulteration or misbranding—

mixtures or compounds which may be now or from time to time hereafter known as articles of food, under their own distinctive names, and not an imitation of or offered for sale under the distinctive name of another article.

This proviso has caused untold difficulty in the administration of the law. The department viewed this case as offering an opportunity for obtaining a clear interpretation of the act and recommended an appeal to the Supreme Court. The Department of Justice, upon consideration of the case, however, thought it inadvisable to authorize a petition for a writ of certiorari. Therefore, an interpretation of this difficult proviso by the court of last resort could not be secured. Lacking such an interpretation, the Food and Drug Administration believes that the appellate court's decision will unquestionably result in the adoption by some manufacturers of distinctive trade names as a subterfuge to cover debased, adulterated, or low-grade products, to the disservice of consumers and demoralization of legitimate trade. It is convinced that such a practice is contrary to the purpose of Congress in the passage of the law. The Food and Drug Administration, therefore, recommends an immediate repeal of that portion of the proviso in section 8 of the act, paragraph 4, in the case of food, which appears to offer a means of exempting mixtures, compounds, and blends from the general prohibitions of the law against adulteration and misbranding.

Twenty-five years' experience in the enforcement of the law leads to certain other definite recommendations for amendment.

The penalties provided in section 2 should be measurably increased. Not infrequently firms are encountered which repeatedly violate the law, paying the fines imposed under this section whenever shipments are apprehended by the department and legal proceedings brought, but apparently regarding these penalties as in the nature of a license fee for doing an illegitimate business. While firms of this character do not persist in business indefinitely, a more positive deterrent effect would be insured if more severe financial penalties could be imposed. It is practically impossible to secure jail sentences, authorized in second offenses, where the shipper is a corporation.

Legislative authority should be granted the Secretary of Agriculture to establish definitions of food products and to prescribe limits

of composition for manufactured articles sold under the defined names, which could be pleaded as the basis of an offense in cases where products fail to meet these definitions and tolerances. The definitions and tolerances for food products issued by the department in the past were merely administrative and can not be pleaded as a basis for the establishment of a violation. Where the validity of the definitions and tolerances is challenged, the department must support them through the employment of experts to prove that the product in question is not entitled to be sold under the name on the label or invoice. This procedure has been fairly successful, but it is very expensive. Not only would authority conferred upon the Secretary to establish definitions and tolerances for foods simplify the procedure under the act, but it would also serve to eliminate to a large extent, without court proceedings, the imposition on the public and the unfair trade competition involved in the substitution of spurious articles. Senate bill 1133, introduced in the last Congress, proposes to grant this authority and appears to be well adapted for the purpose.

The so-called slack-fill bill, House Resolution 8, is intended to prohibit the use of deceptive packages and has been passed by the House on several occasions. It is now pending before the Senate Committee on Agriculture and Forestry. The passage of this bill would materially increase the protection of the public.

The Food and Drug Administration recommends that the proviso to section 7, paragraph 1, in the case of drugs, be changed to include only drugs used for manufacturing purposes and be made applicable only to those substandard drugs which the pharmacopœia or formulary may specify as suitable for manufacturing purposes. There is no evident reason why preparations of medicines (not crude drugs) should be sold under pharmacopœial or formulary names, if they fail to meet the pharmacopœial or formulary tests. The Food and Drug Administration believes that if a pharmacopœial or formulary name is used in the labeling of a drug preparation, that preparation should meet, in all respects, the pharmacopœial or formulary requirements. However, there is justification for traffic in certain substandard crude drugs where the product is to undergo a manufacturing process by means of which the finished article will meet all pharmacopœial or formulary requirements.

PLAN OF ENFORCEMENT

Following the passage of the food and drugs act, when adulteration and misbranding prevailed so extensively in food and drug fields, enforcing officials had no trouble in collecting samples that had been shipped in interstate commerce and against which a charge could be made, and upon which a prosecution could be maintained. A few years of vigorous enforcement of the measure, however, changed that picture. Gross adulteration and obvious misbranding became less prevalent. More subtle and in consequence more damaging forms of adulteration and misbranding began to appear. It became necessary to adopt a new form of regulatory procedure to meet this changed condition, and what is known as the project plan resulted. One reason for the adoption of this plan was to avoid the great expense incident to the collection and analysis of unlimited

numbers of samples of unknown character. With a necessarily limited force an undirected plan of sampling is not only expensive but ineffectual.

The project plan aims to develop reasons for the selective collection of samples, rather than merely random collections. This method is based on a program of factory inspections. If, for instance, enforcing officials know, as a result of factory inspections, that the manufacturers in a certain territory are engaged in an earnest effort to observe the terms of the law and to market only those products that comply with them, there would be no reason for the extensive collection of samples from such firms. On the other hand, indications of illegal practices revealed through factory inspections serve as a guide in the intelligent collection of representative samples.

The project system, as now in force, is of distinct advantage in that it permits concentration on forms of violations most vital to the public health and economic well-being. The facilities at the command of the Food and Drug Administration are not sufficient to permit a complete coverage of the entire food and drug manufacturing industries. It is true that enforcement agencies must have a knowledge of and keep under surveillance the entire field, but it is equally true that in the case of certain foods and drugs adulteration or misbranding is practically never found. The Food and Drug Administration, then, is enabled by the project method to concentrate its working forces and its funds largely upon those products which are most commonly found to violate the law and upon those violations which constitute a gross imposition upon the health and purchasing power of the public.

As stated in the last annual report, this enforcement system is based on four simple principles: (1) As nearly complete knowledge as possible, on the part of the enforcing agencies, of the practices of every branch of the food and drug industry, to guarantee proper detection of probable violations and the identification of those manufacturers whose operations are apt to require surveillance; (2), uniformity of regulatory action where the same type of violation exists; (3) enlightenment of all manufacturers and shippers within the jurisdiction of the law as to the legal requirements imposed upon them to insure a maximum degree of voluntary compliance by that great majority of food and drug manufacturers who are honestly endeavoring to market legal products; and (4) the classification of offenses in the order of their importance, from the standpoint of public health and economic interest, with a concentration of regulatory activities against those which are most serious.

In so far as corresponding State statutes and local ordinances will permit, the project operations are coordinated with the activities of State and municipal agencies. The administration has maintained for years an office of State cooperation, and this facilitates the interchange of information between State, city, and Federal enforcing officials and increases the protection which such laws give the public.

IMPORTANT CASES

In connection with recommendations for amendment of the law, reference has already been made to the adverse decision rendered

in the Bred Spred case. Certain other cases are worthy of particular note.

On October 17, 1930, the United States District Court for the District of Connecticut rendered a judgment against the department dismissing a libel entered by the Government against certain stocks of a drug preparation known as "Lee's Save the Baby" which had been shipped in interstate commerce and seized by the Government in 1929. The department charged that the preparation violated the food and drugs act in that it made false and fraudulent claims on the label with regard to therapeutic value in the treatment of such diseases of children and adults as colds, coughs, grippe, croup, bronchitis, pneumonia, etc. It was the contention of the department that this preparation contained no ingredient nor combination of ingredients capable of producing the effects claimed, and that the therapeutic claims were false and fraudulent.

The defendant presented evidence purporting to show that he had not made positive claims for cure on the label of his preparation and indicating that, since his preparation could be considered as alleviating suffering in the diseases mentioned, it would therefore aid nature in effecting a cure.

While welcoming challenges to the purpose and intent of the food and drug law, and while believing that only through court decisions can the law be clarified on points that have been and may be in the future confusing, the Food and Drug Administration, nevertheless, is of the opinion that the judgment rendered in this case was damaging to the effective enforcement of the food and drugs act and to the purpose of the act itself. This particular action was initiated under the Sherley amendment, and the administration was convinced that the character of the claims made for the preparation was contrary to the letter and spirit of the statute. The article was recommended especially for children, a class of patients whose resistance to the attack of respiratory disease is low and for whom neglect or improper treatment in the early stages of such attacks may result in permanent injury and not infrequently in death. The case was especially illustrative of the serious conditions which led, in the beginning, to the passage of the act, since a primary purpose of the statute is the protection of the public health. The department has urged the Department of Justice to permit appeal of the decision to the circuit court with eventual review by the Supreme Court, if necessary, in the hope that definite enlightenment as to the scope of the law may be obtained thereby. The Food and Drug Administration believes that a policy of enforcement as important to the public health as that prevailing in the control of products subject to the Sherley amendment should not be modified until it is shown to be in conflict with the law as interpreted by the Supreme Court.

Another important action of the year involved a medical preparation, B. & M. External Remedy, shipped by a Boston, Mass., concern to consignees in different parts of the country. The product was a liniment, made of turpentine oil, mustard oil, ammonia, water, eggs, and small quantities of other ingredients. The manufacturer made therapeutic claims for it in the treatment of such diseases as cancer, tuberculosis, pneumonia, influenza, locomotor ataxia, and other maladies. A number of shipments of the remedy were libeled by the Government, and the manufacturer gave every evidence of intending

to contest the case. In addition to a general denial of the charge that the medicine was ineffective, the claimant also advanced a defense of *res adjudicata*, alleging a successful defense of a previous case brought by the Government against the product. The court set March 30 for the trial, and the Government was prepared to meet the defense of *res adjudicata* and to prove, by expert testimony, that the liniment could by no means be considered a treatment or cure for the diseases mentioned upon the label and that consequently the article was violative of the food and drugs act. The manufacturer, however, elected to withdraw its answer and consented to a judgment of condemnation.

The litigation involving B. & M. External Remedy did not, however, terminate with the conclusion of the libel actions. While the latter were pending, the manufacturer sought an injunction restraining the department from causing to be made so-called "multiple seizures" of the product. The Supreme Court of the District of Columbia sustained the Government's motion to dismiss the bill. The manufacturer appealed this decree to the Court of Appeals of the District of Columbia, which remanded the case to the lower court for further proceedings. At this point the matter now stands. While the termination of the libel actions without contest renders the injunction issue of small importance, so far as B. & M. External Remedy is concerned, the broad issue whether the department has authority under the law to institute multiple seizures of products which it considers, on the evidence before it, to be in violation of the act, still remains a question for judicial determination which certainly should have consideration by the court of final resort.

The department resorts to multiple seizures only in cases where the evidence before it warrants the conclusion that the article is of such a nature that it should be summarily removed from the market in the interest of the public.

TYPICAL ACTIVITIES UNDER THE FOOD AND DRUGS ACT

McNARY-MAPES AMENDMENT

An extremely heavy burden was thrown upon the technical forces of the administration by the passage, on July 8, 1930, of the McNary-Mapes amendment to the food and drugs act. This amendment, popularly known as the canners' bill, authorizes the Secretary of Agriculture to promulgate from time to time reasonable standards of quality, condition, and/or fill of container for each generic class of canned food, except meat and meat products and canned milk. It also authorizes the Secretary to prescribe a form of statement which will clearly differentiate substandard articles from those which meet the standards. That designation is "below United States standard, low quality but not illegal." The amendment further authorizes the Secretary of Agriculture to establish and promulgate definitions of fill of container for classes of canned food coming within the purview of the amendment.

Since no special appropriation was made for carrying on work under this amendment, many other technical investigations of the food control laboratory were temporarily forced into the background following the passage of the measure. Formulation of standards of

quality, condition, and fill of container necessitated by the law is a pioneer task. Six important classes of canned foods were selected for preliminary work, foods for which there was a serious need of standardization to insure a good table quality to the consumer. The classes chosen were peas, peaches, pears, apricots, cherries, and tomatoes. The problem in each case was virtually this: What particular features of quality and condition does the consumer expect when he orders, for example, a can of peaches or peas without classification, and what departure below normal might occur before he would demand some sort of informative labeling to indicate the deviation from the conventional style of pack and the expected quality of the product? Through the administration's field forces and through trade organizations, hundreds of cans of the various foods under consideration were secured from all the producing sections of the United States. Special attention was given to products of borderline type or of unsatisfactory quality from the consumer's standpoint. The lower limits of the various quality factors involved in each particular food were determined by conferences between department experts and those of the trade, as well as with representative consumers. These limits fixed, the problem became one of establishing definite scientific methods for the measurement of quality factors in such a manner that the results would be independent of personal bias and readily presentable before a court of law. The pioneer nature of this work may be appreciated by the fact that the administration's technical experts were forced to invent an apparatus for the accurate measurement of tenderness, one of the most important quality factors of many canned foods. This apparatus, described in Department Circular No. 164, entitled "An Apparatus for Determining the Tenderness of Certain Canned Fruits and Vegetables," has already been found suitable for determining the tenderness of peas, peaches, pears, and apricots, and it seems likely that it will find much wider application to other canned and raw foods.

On February 16, standards for canned peas, peaches, and pears were officially promulgated in Service and Regulatory Announcements, F. D. No. 4. The standards went into effect 90 days from that date, or May 18, 1931, thus being applicable to the 1931 pack. The official standards for canned apricots, cherries, and tomatoes were announced April 27, 1931, going into effect 90 days from that date, as prescribed by the law. Other standards will be announced as rapidly as they are formulated.

The closing weeks of June marked the beginning of the second phase of the Mapes amendment work, which involved the inspection of canneries in actual operation. This work had the dual purpose of observing conformity to, and reasonableness of, the standards, and the training of the administration's field forces in this new type of inspectional work. Preliminary investigations have indicated a whole-hearted compliance on the part of canners and fairly general satisfaction with standards now promulgated.

SEIZURES, PROSECUTIONS, AND SAMPLES

Approximately 31,860 samples of foods and drugs were collected and examined in the course of interstate and import operations under the law, during the year. In a large number of cases, examinations

consisted only of chemical analysis, but a material percentage of the total number of samples analyzed required supplementary bacteriological, microscopical, or pharmacological examination. The total number of samples given includes those upon which legal actions were based, as well as those of an unofficial or informative character, collected as a guide for determining the necessity of regulatory operations. Tables 1 and 2 contain condensed summaries of the actions taken under the domestic and import provisions of the act, respectively.

TABLE 1.—*Summary of prosecutions and seizures under the food and drugs act, fiscal year ended June 30, 1931*

Item	Prosecutions	Seizures	Total
Food.....	293	698	991
Drugs.....	183	702	885
Stock feeds.....	71	30	101
Total.....	547	1,430	1,977

TABLE 2.—*Import samples examined at port laboratories during fiscal year ended June 30, 1931*

Item	Detained	Released	Total
Foods.....	2,469	4,899	7,368
Drugs.....	1,321	1,842	3,163
Total.....	3,790	6,741	10,531

In addition to the samples listed in Table 2, many thousands of inspections were made of both food and drug consignments offered for entry. Penalties in bonds collected during the year amounted to \$13,070.46.

In the following pages no attempt is made to present detailed reports of each regulatory action, but definite classes of offenses are illustrated by typical cases encountered during the year.

FOOD ADULTERATIONS INVOLVING PUBLIC HEALTH

Foods may become dangerous through contamination with poisons, through the development of certain forms of bacterial decomposition, or through the presence of disease germs.

During this year, as during 1930, no cases of botulism attributable to commercially packed food were encountered. The majority of packers exercise meticulous care in processing their food in such a manner as to prevent decomposition, but there are always a few small operators who neglect the proper precautions, and the output of these requires continual supervision. In acid canned foods, where it is improbable that any bacterial toxins dangerous to health will develop, there is slight menace to health. It is, therefore, nonacid products, such as turnip greens and spinach, sweetpotatoes, pumpkin, and string beans, which occupy the major portion of the administration's attention during the year. In certain sections of the country a few small canners still use the so-called "open-kettle" method of processing, in which the temperature of the food can not go above the boiling point of water. Such methods of processing

are extremely unsafe. Cannerymen found to be using this primitive procedure are cautioned against the grave danger involved in it. Interstate shipments of foods processed by this method were followed up, and whenever decomposition was demonstrated, were seized and destroyed.

The growing of fruits and vegetables frequently necessitates the addition of poison in the form of sprays to protect the crops from insect and fungous pests. A systematic campaign to determine the character of sprayed fruits and vegetables entering interstate commerce, and their status under the provisions of the law, was inaugurated in 1919. Succeeding seasons have seen increased activity in the study of sprays in their effects upon fruits and vegetables until, at present, the project has attained such importance that during the shipping season much time of the field force is devoted to this work.

The administration throughout the season maintained very close cooperation with State food officials, as well as with growers and shippers, in studying the matter of spray residue on fruits and vegetables. Thousands of samples were collected and examined. There has been a very general adoption of methods developed by the department and by collaborating State agencies for the removal of arsenical residue by appropriate cleaning processes. This being the fact, it was seldom necessary to resort to legal action against shippers during the year, although 10 seizures of fruits and 9 of celery were made. The reporting of excessive residue almost invariably led the responsible owner to employ successful cleaning processes, but his failure to do this inevitably led to detention of the product by appropriate legal action until cleaning was effected.

Food officials are frequently called upon to study cases of food poisoning due to the development of bacteria in foods carelessly processed or cared for. As has been the case in the past, the Food and Drug Administration technicians were called upon for assistance in outbreaks of sickness where defective food was suspected to be the causative factor. Aid was rendered in 16 alleged food-poisoning cases, during the year. In only 4 of these did examination of the samples submitted indicate that there was a possibility of their having caused the outbreak. One of these was a sample of home-canned spinach which was found to contain type A botulinus toxin, well known to be extremely deadly. A sample of cake was found to contain toxin-producing coccus organisms, and a series of samples connected with another outbreak was found to contain bacteria of the Salmonella group. In the latter case, it was apparent that the source of contamination was some person who prepared the food in the kitchen. Illness caused by eating pokeweed salad was found to have been caused by failure to remove the poisonous saponin in the process of preparation. At the present time, three outbreaks of food poisoning are under investigation. One in Los Angeles in which commercially canned antipasto and home-canned mushrooms are suspected; one in Georgia in which commercially canned sausage is incriminated; and one in Baltimore, which is considered a doubtful food-poisoning case. An outbreak of food poisoning in Texas was investigated by department field men and found to be caused by the accidental use of commercial lead acetate for making pie meringue. The fact that this poison is commonly known as sugar of lead may

furnish a clue to how such a blunder was made. In none of the cases involving products moving in interstate commerce was evidence obtained that the products were contaminated as originally marketed. All facts obtainable pointed to carelessness in the handling and storage of the foods after the original containers were opened.

FOOD ADULTERATIONS INVOLVING OFFENSES AGAINST DECENCY

In the second group of law violations may be classed offenses against aesthetic taste. Examples of this class are worm-infested fruit or vegetables and various decomposed foods.

A constantly pressing problem involving filth in the food supply is that of controlling traffic in fresh, dried, or canned fruits infested with worms or other impurities. The United States imports annually large quantities of dried figs from Turkey and Greece and smaller amounts from other south European countries. The department is obliged each year to reject numbers of importations because of the inclusion of wormy, filthy, or otherwise decomposed figs. Most figs imported into the United States arrive at eastern seaboard ports. During the calendar year 1930, the administration's eastern district officials examined more than 14,000,000 pounds and detained approximately 30 per cent of them for failure to meet Federal food and drugs act standards. Notwithstanding the continued heavy detentions it is believed that the condition of imported figs is progressively improving.

During the past year, one importer, a large proportion of whose goods was detained, attempted to dispose of his products while still under detention. He took possession of them under a redelivery bond and offered them for sale. Immediate steps were taken to prevent the distribution of the goods. Twenty-four seizures were made, and the products remaining on hand were immediately called into customs custody.

The canning of prunes, an expanding industry in the Pacific Northwest, necessitated some control by department agents during the past year. The amount of production of canned prunes increased from 120,000 cases in 1919, to 930,000 cases in 1929. On account of unfavorable weather conditions the past season, however, the pack decreased to 660,000 cases.

The harvesting season usually occurs during September. During the latter part of the 1930 season continued rains and cloudy weather were responsible for the rapid development of brown rot, which infected approximately 40 per cent of the crop and caused heavy losses to the industry. Brown rot is a form of mold, common to stone fruits. It spreads very rapidly by means of spores when the proper conditions of humidity and temperature are present. Under favorable conditions a perfectly sound prune will be completely rotten four to five hours after inoculation. The heavy infestation during the 1930 season necessitated immediate regulatory action. Western district officials collected 157 samples for examination. This resulted in 20 seizures involving about 4,500 cases of canned prunes. The maximum amount of brown rot found in any one can examined amounted to 76 per cent. Twenty-seven canneries located in Washington and Oregon were visited in connection with this project, and six of the concerns were cited to hearings for the shipment of adulterated food

in interstate commerce. Oregon State food officials cooperated effectively with the department in this work.

A few years ago it was a common practice to include a certain number of barrels of cull poultry with every car of the dressed product. The cull birds, in addition to being of poor appearance and edibility, were often seriously diseased or decomposed. Surveillance of incoming lots of dressed poultry was maintained during the year by all stations, and this objectionable practice has been almost completely eliminated. Some shippers were found attempting to mix in a few culls with good birds in barrels labeled as No. 2 grade. Eleven seizures of this type of product were made.

During the winter of 1931 large lots of rabbits, both dressed and not dressed, packed in barrels, were received at Chicago. Investigation of samples of this food showed that much of it was objectionable. The department's Chicago station, in cooperation with local health officials, instituted a carefully conducted project which resulted in 12 seizures. It is to be noted that practically all seizures were of wild rabbits, animals shot and packed on the plains of the Middle West.

DECOMPOSED FISH

The Food and Drug Administration paid the usual attention to the condition of fresh fish, canned fish, and fish products during the year. Fish studies were an important project in all the districts. A total of 110 seizures was effected, and 81 prosecutions were instituted against shippers violating the law.

An interesting case concluded during the period involved interstate shipment of approximately 43,000 cases of decomposed canned salmon. On March 26, Federal Judge George M. Bourquin, of Seattle, Wash., imposed fines upon a Seattle manufacturer and a broker for shipping the salmon and expressed regret that the penalties provided under the law for first offenses did not permit the imposition of jail sentences.

Much attention has been given also to the presence of parasites in fresh fish. It is not definitely established that parasites dangerous to human health are present, but department investigations have made it quite evident that certain fish are infested with parasites so disgusting in appearance as to constitute an offense against decency and to render the product adulterated within the meaning of the food and drugs act. The investigation has resulted in valuable information concerning the existence of parasites in fresh fish and in the training of a group of analysts in proper methods of examination. Thirty-three consignments of infested fish from Canadian waters were denied entry into the United States between January 1 and June 30, 1931. Ten shipments moving in interstate commerce were libeled. This project is to be continued on a broader basis throughout the coming year.

The New England coast was visited with a serious epidemic among young herring during the period. These fish are used in the sardine-canning industry. Experimental packs of normal and infested fish were prepared, and canners were advised as to proper methods of segregating the diseased fish. Careful supervision of packing operations was undertaken by the Maine State authorities. Representatives of the Food and Drug Administration rendered cooperative assistance. That this supervisory move was effective was shown

by the fact that routine samples of suspected sardines in interstate commerce showed no objectionable fish.

The tuna fish-packing industry of the United States is confined virtually to the coast of southern California. In recent years, the department has been giving very careful attention to tuna canning and packing methods and to the condition and purity of fish shipped interstate. During the fiscal year 1930, in fact, the department found it necessary to remove from trade, either by seizure or informal embargo, over 50,000 cases of tuna fish. Through the excellent cooperation of the California State Department of Public Health, an effective State inspection service is maintained now that provides for the close surveillance of all cargoes of tuna entering the canneries from domestic waters. The Food and Drug Administration maintains an adequate check on all import receipts, either from Mexican or Japanese waters, and at the same time makes frequent check examinations of fish packed under State inspection. As a result of this activity, a marked improvement in the quality of current packs is noted. Up-to-date electrically refrigerated boats are entering the fishing fleets and the fishermen are now using the most approved methods of handling the tuna from the time the fish leave the water until delivery is made to the canneries. Japanese tuna now being delivered are marked individually to show that they have been inspected before being shipped, and the quality of deliveries indicates a rigid segregation of objectionable material. Records covering inspection work from January 1, to May 31, 1931, show that 789,456 pounds of tuna were rejected as unfit for consumption. This was but 5.25 per cent of the total landed weight of more than 15,000,000 pounds. These figures, as compared with individual boat landings of the previous year, when as high as 80 per cent of rejections were encountered, indicate the increased care and improved facilities for handling now provided by the fishermen. Five seizures of tuna were made during the year, and two prosecutions of shippers of this product were instituted. Twelve seizures and three prosecutions were instituted the previous year.

BACTERIOLOGICAL EXAMINATIONS

All samples of food suspected of decomposition, insect infestation, or the presence of filth, are not only subjected to the scrutiny of the chemist, but are also carefully analyzed by the bacteriologist or microanalyst. Table 3 gives some idea of the character and magnitude of these bacteriological examinations.

TABLE 3.—*Bacteriological examinations made from July 1, 1930, to June 30, 1931*

Product	Import		Domestic		Total	
	Samples	Containers	Samples	Containers	Samples	Containers
Acidophilus preparations.....	0	0	4	29	4	29
Dairy products.....	2	3	0	0	2	3
Fish and shellfish.....	48	512	92	3,819	140	4,331
Fruit and vegetables.....	76	1,029	534	10,180	610	11,209
Water.....	32	146	101	312	133	458
Miscellaneous.....	0	0	77	115	77	115
Total.....	158	1,690	808	14,455	966	16,145

FOOD VIOLATIONS INVOLVING ECONOMIC CHEATS

Serious economic cheats have been encountered frequently in misbranded foods and drugs, that is, products labeled in such a way as to deceive or mislead the purchaser. The latter form of violation bulks far larger in the cases instituted under the law than does the public-health form of violation. Offenses involving deception and economic fraud are injurious alike to the consumer and the manufacturer who seeks to offer a product fully complying with the law.

Among products against which action was directed because of violation involving economic frauds, were vegetable oils mixed with cheaper and less popular oils without appropriate label declaration, honey sophisticated with sugar sirup, so-called pure fruit jams and jellies debased with undeclared pectin and sugar sirups, cacao products adulterated with cheaper and less desirable fats, stocks of butter and cheese adulterated with water (the cheapest adulterant), stock feeds containing excess water, and many other products. A few characteristic cases of violations involving fraud are given.

Late in April the department seized approximately 50 tons of mixed barley and oats stock feed, adulterated with water, and shipped by a Memphis, Tenn., firm from that city to Arkansas and Mississippi towns. Analysis proved that each 100 pounds of the feed contained 3.7 pounds of added water. The addition of water to stock feed constitutes a violation of the Federal food and drugs act. Had the shipments reached the buyers, they would have paid feed prices for nearly 2 tons of ordinary tap water.

In November the judge of the United States District Court, Boston, Mass., imposed fines aggregating \$1,000 upon an individual operating from New Bedford, Mass., for shipping interstate scallops adulterated with water. The fish dealer had been found guilty of the same offense several times before and had been fined. In the latest case, the judge imposed a fine considered sufficient to discourage the operator from offending against the law in the future.

Creameries in the administration's central district territory manufacture approximately 80 per cent of all the butter consumed in the United States. Careful scrutiny is made of all this butter inasmuch as it has been the experience of the department in the past that butter is not infrequently found to be short weight or deficient in fat content. The district kept under surveillance some 2,700 creameries in its territory with a view to checking offenses. All of the central district stations, at periodic intervals, examined butter arriving in the terminal markets of the larger cities of the Central West. Where it was found short weight or deficient in fat, the shipment was seized. It was necessary to recommend seizure action against 56 shipments, and approximately 85,000 pounds actually were seized.

ACTIONS ON DRUGS

Fraudulent claims made regarding the curative values of an illegal remedy have always been regarded by the administration as a definite public-health menace, not only because such a product may actually harm the user, but also because its use may cause delay in resorting to rational methods of treating the disease. Fraudulent representations have been made at one time or another, during

the 25-year history of the act, for thousands of so-called patent or proprietary medicines. These include preparations advertised and sold for use in such extremely dangerous diseases as tuberculosis, cancer, influenza, rheumatism, syphilis, and diabetes, and for a great variety of diseases of such vital organs as the liver, kidneys, stomach, and heart.

Five hundred and seventy seizures of falsely and fraudulently labeled proprietary medicines were effected during the year. Of these, 123 were preparations falsely labeled in such ways as to state or imply that they were effective remedies against influenza. While the influenza epidemic of the past winter was not nearly so serious as earlier outbreaks, the administration continued its campaign against so-called influenza remedies.

Among the most prominent of the fraudulent medicinal products are so-called rheumatism, malaria, and diabetes cures. Many miscellaneous aches and pains are classed as rheumatism, and no preparation can have a favorable effect on all of them. There is only one recognized medical treatment of diabetes, and even that, insulin, must be administered by one thoroughly familiar with the nature and treatment of the disease. Quinine is recognized as a specific against malaria, but many of the malaria preparations encountered during the year did not contain the prescribed dosage.

The campaign against misbranded dentifrices and antiseptics was continued. Basing its action upon recognized dental opinion that there is no known dentifrice which can be considered a cure, or a successful treatment, for such serious oral diseases as pyorrhea and trench mouth, the administration took action against 64 consignments of dental preparations shipped in violation of the law. Within recent years simple preparations possessing only antiseptic power have been advertised as effective treatments or cures for many serious diseases. In the course of the attention given this type of product, during a period of nearly five years, the Food and Drug Administration has collected and analyzed almost 700 antiseptics and found a number of them to have little or no antiseptic value. Continuing the regulatory attention given this class of products, the administration libeled 29 consignments found to violate the act.

An interesting activity of the administration's western district involved the control of imported remedies. Many of these came from manufacturers in oriental countries, seeking to exploit the English-speaking peoples with worthless products. The San Francisco station detained 101 shipments of such misbranded medicines, and the destruction of most of them was effected. Some entries were permitted after the removal of the English misbranding.

During the year a lamentable outbreak of paralysis, occasioned by the consumption as a beverage of illicit Jamaica ginger, occurred in California. A similar outbreak in other States was described in the annual report for 1930. Cooperative work with prohibition authorities and State health officials resulted in the seizure under the food and drugs act of five lots of the poisonous Jamaica ginger, in addition to the removal from the market by other legal agents of numerous consignments. While it has been definitely determined that the source of the material was one which surreptitiously supplied a large traffic in alcoholic beverages, the most intensive search by all agencies has thus far failed to locate and identify the indi-

viduals responsible for the manufacture and shipment of the goods involved in the California outbreak.

Previous annual reports have made reference to regulatory work directed against impure anæsthetic ether. The chief difficulty encountered with ether is its tendency to develop aldehydes and peroxides, and there seems good reason to believe that these develop while the ether is in storage. On March 20, the United States marshal for New Jersey put a period to the history of 120,000 cans of substandard and adulterated ether, an old war-time stock, when, as a result of regulatory action under the food and drugs act, he was instructed by a Federal court to destroy it. Government tests proved the ether to be high in acidity and inferior to the standard quality prescribed by the United States Pharmacopœia, and thus adulterated under the law. A total of 82 seizures of anæsthetic ether was made. Continued regulatory activity directed against anæsthetic ether during the last five years has brought about, as Table 4 shows a progressive improvement in the quality of ether on the American market.

TABLE 4.—*Anæsthetic ether examined 1926 to 1930, inclusive*

Calendar year	Cans examined	Cans not of U. S. P. quality	
	Number	Number	Per cent
1926	470	162	34
1927	955	244	25
1928	1, 292	166	12
1929	3, 464	329	9
1930	6, 189	313	5

Four hundred and twenty-one biological assays of crude drugs and drug preparations relied upon in the treatment of serious diseases were made during the period by the pharmacological laboratory.

There were examined 143 samples of crude ergot taken, for the most part, from consignments offered for entry into the country. Of these, 105 were found of satisfactory quality. Thirty-eight consignments were refused entry because of deteriorated condition or low potency. Examinations were made of 131 ergot preparations. Seventy-four regulatory actions were inaugurated because of adulteration or misbranding, or both. Fifty-seven of the samples examined were found to be of satisfactory quality.

Twenty-two samples of digitalis leaf offered for import were examined. These were all found of satisfactory quality and were permitted entry. Sixty-one samples of preparations of digitalis were examined. Of these, 52 were found to be neither adulterated nor misbranded. Nine regulatory actions based on preparations of digitalis were inaugurated.

Five samples of aconite root were examined and found to be of the quality specified by the pharmacopœia. Thirty-two samples of aconite preparations were examined; 21 met the requirements of the law, and 11 formed the bases for legal action.

Thirteen samples of epinephrine were examined and found to meet the pharmacopœial specifications. Of seven samples of pitui-

tary extract, only one was found not to be of pharmacopœial strength. This one was double strength. The consignment represented by the sample was seized.

Of five samples of squill preparations examined, two were found to be illegal. Legal procedure was inaugurated. The shippers were cited to show cause why prosecutions should not be instituted on the basis of the adulterations.

One sample of insulin and one of cannabis fluid extract were found to be of satisfactory potency.

The pharmacological laboratory also supplied bio-assay standards to control laboratories. During the fiscal year, 158 such samples, of which 78 were standard fluid extract of ergot, were furnished. The administration's research on the factors involved in the deterioration of tincture of digitalis, begun some months ago, is in progress.

For 25 years, the department has been endeavoring to protect farmers against the sale of falsely and fraudulently labeled veterinary proprietary medicines. Considerable progress was made during the last year in eliminating from interstate distribution drug products labeled as preventives or treatments for contagious abortion and sterility or barrenness of cattle, dysentery or scours, and black leg of calves, hog cholera, influenza of hogs, swine plague, mixed infections of hogs, fowl cholera, pullorum disease or diarrhea of chicks, coccidiosis of chicks, contagious or infectious roup of fowls, chicken pox or diphtheria, gapes of chicks, blackhead of turkeys, influenza, distemper, and heaves of horses, and tuberculosis of cattle, swine, and poultry. Recent investigations have shown that interstate commerce has been cleared of preparations falsely and fraudulently labeled as having therapeutic value for contagious or infectious abortion, hog cholera, and tuberculosis of livestock. Drug products labeled for necro or necrotic enteritis of pigs have been studied and investigated. A preliminary report of tests of two such products shows that these types of preparations are apparently not effective in the treatment of the disease. In view of the economic importance of the control of internal parasites to the livestock industry the administration has given considerable attention to the various products offered for this purpose. Critical tests of a number of worm expellers for livestock or poultry have been conducted. The tests show that many of the so-called worm expellers or vermifuge products on the market are not efficacious. A number of manufacturers were found to be shipping mislabeled mineral mixtures interstate.

The Government secured a verdict in a contested court case at New Orleans, La., against four veterinary preparations recommended for diseases of dogs, manufactured by the S. A. Crisp Canine Co., of Blacksburg, S. C. The products involved were a black-tongue preventive, a black-tongue remedy, a distemper remedy, and a running-fit remedy. Seizure was instituted against the preparations on the grounds that the therapeutic claims on the labels were false and fraudulent. The jury returned a verdict for the Government on all charges. This case will undoubtedly have an important bearing on future enforcement of the food and drugs act against misbranded veterinary drug products, as well as preparations recommended for human use.

SCIENTIFIC INVESTIGATIONS

With the rapid development of the food and drug manufacturing industries, both in the number of products and in the increasingly complicated nature of these commodities, has come an increased need for careful scientific investigation of the nature and composition of foods and drugs. One of the first necessities, following the passage of the food and drugs act, was the development of means of research into foods and drugs for the purpose of establishing definite information as to what constitutes adulteration under the law. That necessity has not disappeared. Within recent years special methods of analysis have been elaborated to determine not only normal food and drug constituents but also to ascertain what changes they undergo in the course of manufacturing, storing, and aging.

The investigational work of a technical nature made necessary by the passage of the McNary-Mapes amendment has already been described.

The practice of substituting mixtures of various wheat products for whole-wheat flour has assumed such proportions that a method for the identification of such mixtures has become essential. Such a method has been developed, and the process of establishing standards under it is now under way. Various parts of the wheat kernel have different compositions, and the method is based on the relative quantities of the various constituents found in the different parts of the wheat. A paper, *The Determination of Starch in Flour by Diastase-Acid Hydrolysis*, was published during the year. The method outlined is not more time-consuming than the existing official method and has the advantage of being more specific. The published data indicate that it determines true starch with a high degree of accuracy in commercial starches and in wheat flour. Its applicability to determining added starch in other food products, such as canned goods and peanut butter, is being tested. The method has been found of great service in the whole-wheat flour project already mentioned.

An investigation of malted milk showed that the fat contributed by the cereal constituents does not markedly change the Reichert-Meissl value of malted milk from that of pure butterfat. In connection with factory inspections by administration chemists, authentic samples of the cereal ingredient of malted milk were secured, with the object of studying further the constants of the cereal fat, on which there are very meager data in the literature. A paper called "*Determination of the Reichert-Meissl Value of the Fat of Malted Milk*" has been prepared for publication.

A recent development in the chocolate industry has been the addition of lecithin from soybean, or other sources, to chocolate. Various advantages are claimed for its use. It became necessary to devise an accurate method of determining the presence of lecithin in cacao butter, and a method employing a combination of solvents has been found to give acceptable results. The investigation has been practically completed, and the results will be published in the near future.

During the year, one of the most difficult analytical problems in food-control work was practically completed. This was the study of a procedure for determining malic acid in fruit products. A paper describing the method is in course of preparation. The basic prin-

ciple of the method consists in the removal of citric acid by treatment with tribasic lead acetate. The total malic acid is determined by oxidation with alkaline permanganate and the laevo (natural) malic acid by polarization of the calcium salt. The accurate determination of tartaric, citric, inactive malic, and active malic acids in fruit products is now possible. It remains to develop methods for determining succinic and lactic acids, and this investigation is well under way.

Collaborative work with the Association of Official Agricultural Chemists, continued from past years, included, among other things, work on the following methods of analysis: Fat in malted milk; protein in milk; tartaric and citric acids in fruit products; total solids in jams and jellies by refractive index; iodine, iron, and copper salts in feeds; starch in flour, crude fiber in breads and pastes; fat in breads; chlorine in bleached flour; carbon dioxide in baking powder; polarization of vinegar; water in oils and fats; caffeine in decaffeinated coffee.

FOOD STANDARDS

The food standards committee held two meetings during the fiscal year. Standards were formulated and approved for dextrose (including anhydrous dextrose and hydrated dextrose), for canned tomato juice and for whole-wheat bread. These products heretofore have not been defined. The committee also revised the existing definitions and standards for white bread, rasin bread, Boston brown bread, and sorghum sirup. The revised standards for these products have been officially announced.

On December 26, 1930, the Secretary's decision defining the status of corn sugar (dextrose) under the law was announced in the following terms:

Corn sugar (dextrose) when sold in packages must be labeled as such; when sold in bulk must be declared as such; but the use of pure refined corn sugar as an ingredient in the packing, preparation, or processing of any article of food in which sugar is a recognized element need not be declared upon the label of any such product.

Nothing in this ruling shall be construed to permit the adulteration or imitation of any natural product such as honey by the addition of any sugar or other ingredient whatever.

In order to bring the existing definitions and standards for food products into conformity with this decision, the definitions and standards as published in Service and Regulatory Announcements, F. D. No. 2, and supplements were revised and, where necessary, were rewritten.

CERTIFICATION OF COAL-TAR COLORS

In the routine examination of food colors to determine their compliance with the requirements of the law, 1,341 batches representing the output of 52 firms were certified. The colors certified included 290,715 pounds of straight dyes, 25,329 pounds of repacks, and 337,814 pounds of mixtures. Fourteen batches of straight dye and 10 batches of mixtures were rejected during the year.

A certain amount of research work, designed to improve methods for the analysis of food colors, was carried on during the fiscal

year, and the following papers have either been published or prepared for publication:

Use of Buffers in the Determination of Colors by Means of Titanium Trichloride. II

The Quantitative Estimation of Amaranth and Tartrazine in a Food-Color Mixture.

The Direct Electrometric Titration of Certain Coal-Tar Food Dyes.

INSECTICIDE ACT

The insecticide act requires a type of Federal regulation of labeling and manufacture of insecticides and fungicides which will protect farmers, fruit growers, and others who use these products. It insures truthful claims of quality and effectiveness for such materials and prohibits the use of any substance that might injure the plant to which the chemicals are applied.

The modified procedure for inspecting insecticides and fungicides, as outlined in the annual report for the fiscal year 1929, has been continued in the last two years. This procedure provides for basing regulatory operations primarily on information gained as the result of direct factory inspections. It enables the administration to give prompt attention to objectionable labeling and to correct questionable manufacturing processes.

During the year, 1,458 insecticides and fungicides were examined chemically, microscopically, or bacteriologically and, when it was necessary, were submitted to field tests.

	Number of samples
Arsenate of calcium.....	82
Arsenate of lead.....	96
Bordeaux mixture and combinations of Bordeaux with insecticides.....	90
Dips for animals.....	27
Disinfectants, germicides, and bactericides.....	187
Dusting mixtures, agricultural.....	92
Fish-oil and whale-oil preparations.....	6
Fly repellants for animals.....	45
Insect preparations for household use.....	75
Lice and mite killers.....	58
Lime-sulphur solutions and sulphur preparations.....	84
Mange preparations for use on animals.....	20
Miscellaneous.....	16
Miscellaneous insecticide and fungicide preparations for agricultural use.....	209
Moth (clothes) preparations.....	166
Nicotine preparations.....	62
Oil emulsions.....	64
Paris green.....	23
Pyrethrum.....	7
Sodium hypochlorites, chloramines, and chlorinated lime.....	49
Total.....	1,458

Thirty cases representing alleged violations of the law were reported to the Department of Justice during the period for the purpose of instituting criminal prosecution or seizure proceedings. Disposition of 447 cases, involving products bearing labeling that constituted misbranding, was made. The labeling was voluntarily corrected by the manufacturers when the violations were called to their attention, making it unnecessary to resort to legal action. This graphically represents the value of the educational phase of the insecticide act.

Samples were obtained from 104 consignments of insecticides and fungicides offered for entry into the United States. Samples from 45 of these shipments were found, upon examination, to be adulterated, misbranded, or both.

CHEMICAL TESTS

Many new substitutions and combinations used as insecticides and fungicides appeared on the market during the period. An unusual amount of time was required for their routine examination and analysis. Two products of interest recently put on the market are the plant extract anabasine, produced in Russia, and a coal-tar synthetic product, neonicotine, developed through the researches of the Bureau of Chemistry and Soils. Both contain the same active compound, neonicotine, but it had never been reported as having occurred in plants until after it was produced synthetically. Some of the new moth-proofing and seed-treating materials are also exceedingly complex, their analyses often requiring considerable research. Considerable difficulty was also encountered in the evaluation of mixtures containing derris and some of the pyrethrum extracts. In spite of the extra work required for analysis of these new products, and in spite of a limited personnel available for development of general methods of analysis, considerable progress was made. The two methods for detecting mercury in organic materials for seed treatment mentioned in last year's report have been further investigated and presented to the Association of Official Agricultural Chemists with a view to their adoption as official methods.

A study of the Travers' method for the determination of fluorine in insecticides was published in the Journal of the Association of Official Agricultural Chemists. This method is rapid and, except in the presence of boron, aluminum, iron, and lead, accurate. It is considered a valuable method in the analysis of many products which contain fluorine.

In order to aid manufacturers of copper carbonate, extensively used for the control of bunt in wheat, in preparing their labels, a mimeographed leaflet entitled, "Labeling commercial copper carbonate dusts intended for seed treatment" was issued.

BACTERIOLOGICAL TESTS

The administration examined 488 fungicides and insecticides during the year, an increase of about 13 per cent over the figure for last year. Considerable work was done in the testing of disinfectants, and a summary of this experimental work was published in an article entitled "Limitations of Phenol Coefficients of Coal-Tar Disinfectants," in the February, 1931, issue of Industrial and Engineering Chemistry. The work showed that it is impossible to calculate the *Staphylococcus aureus* phenol coefficient from the *Bacillus typhosus* phenol coefficient of coal-tar disinfectants, since the ratios of the two coefficients varied in 206 samples of the emulsion type from 2.0 to 20.0, a discrepancy of 1,000 per cent. For the solution type, the discrepancies were not so great, the ratios ranging in 34 preparations from 1.1 to 2.4.

Recognizing the desirability of uniform methods of testing disinfectants and antiseptics, a bulletin was prepared describing Food and Drug Administration methods for such tests. This is now in the hands of the printer. A paper criticizing reports on various antiseptics and personal disinfectants was presented at the local section of the Society of American Bacteriologists. This showed that many such tests are faulty in that they do not take into account the distinction between inhibition of growth and the actual killing of the test organism.

Other problems to which some attention was paid and on which work is now under way are: The dosage and conditions required for practical formaldehyde fumigation; determination of bactericidal properties of various pure chemicals and of volatile oils; and a study of the resistance of spores to chemicals with a view to establishing a standard of resistance.

FIELD TESTS OF INSECTICIDES AND FUNGICIDES

Effective control under the insecticide act of traffic in insecticides and fungicides requires not only complete knowledge of composition but also a critical study of the label claims made for these products. A determination of the accuracy of these claims necessitates field tests of individual samples under favorable conditions. As a preliminary to the study of individual samples, determinations must be made of the effectiveness, under different conditions of practical use, of the various insecticidal and fungicidal ingredients employed. Depending upon the kind of product under consideration, entomological, fungicidal, or veterinary tests may be required. All of these investigations are the direct outgrowth of the needs of the regulatory work.

ENTOMOLOGICAL TESTS

Much time was given during the year to special investigations of new or little-known insecticide materials and to dosage tests with the standard insecticides. This work is designed to furnish data to assist in criticizing labels when actual tests can not be made at the time the labels are considered, and also to furnish data for use in expert testimony. A somewhat new contact insecticide, rotenone, shows considerable promise and is beginning to appear on the market in proprietary preparations for use on animals and plants and, in some cases, for use in the home. A special study was made of rotenone and some of the other constituents of derris roots. These materials were tested as dusts and sprays against a large variety of insects, and much valuable information was secured. Summaries of some of this work were published in the *Journal of Economic Entomology* during the year. The work on pyrethrum, pyrethrum extracts, and, to a limited extent, pyrethrins, was continued. Experimental work was also done to determine the efficacy of the fluosilicates, naphthalene, and paradichlorobenzene against many insects and also to discover the efficiency of nicotine preparations in the control of chicken lice and mites.

The laboratory at Haddon Heights, N. J., tested various insecticides on the Japanese beetle and the soil-infesting insects, such as cabbage maggots, wireworms, carrot rust fly, and white grubs.

FUNGICIDAL TESTS

Tests of various commercial fungicides were carried on in Oregon, New York, New Jersey, and Maryland and included a determination of the efficacy of preparations against the more important diseases of the grape, apple, peach, cherry, prune, strawberry, tomato, potato, celery, cucumber, rose, hollyhock, delphinium, and some other garden plants. In addition to this routine work under the law, including about the same number of tests as were conducted during the previous fiscal year, special investigations were carried on which yielded knowledge that will be of great value in future criticism of labels under the insecticide act. Comparative studies were made of the several types of "wetable" sulphur fungicides now on the market, including the so-called "flotation" sulphurs, which are by-products in the manufacture of gas, and of finely powdered sulphurs mixed with various conditioning substances, such as casein or glue. All these products have a definite place in the spray schedule on apples and other fruits, as substitutes for the more caustic lime-sulphur solution.

Investigations of several types of dusts used against various plant diseases were made to secure more accurate information as to their limitations. Calcium monosulphide, which is less injurious to fruit and foliage than the standard lime-sulphur solution of commerce, has been used in an attempt to develop an efficient sulphur fungicide. This fungicide has proved quite efficient in Virginia, but tests to date do not indicate an equal efficiency in other States. It is believed that further tests are necessary to permit intelligent consideration of products subject to the insecticide act, and these are in progress at the administration's testing stations in New Jersey, New York, and Oregon.

Investigations of Bordeaux-mixture injury to apples and cherries yielded some valuable information. Tests now show quite definitely that fruit russetting may result from a preblossom application. For middle and late summer applications to apples, however, results with individual samples of Bordeaux mixture vary greatly according to the physical and chemical composition of the material. While tests show that injury can be expected from a Bordeaux mixture which contains an excessively high percentage of copper and a corresponding deficiency of excess lime, there is no assurance that other products are safe on semitender foliage, such as that of the apple tree. The factors which influence Bordeaux injury are not yet well enough understood to enable Federal investigators to judge their properties entirely on the basis of chemical analyses. For this reason, individual tests are usually necessary. When several samples of Bordeaux mixture were tested on cherries, the results differed in some respects from those obtained in other seasons. The addition of a large excess of lime, generally found to be effective in greatly reducing injury, and also desirable in reducing copper and arsenical injury, this year caused a definite shriveling of much of the fruit. This result was evidently associated in some way with the droughty condition of the season.

The drought was also unfavorable for tests against fungous diseases. Since it is important to know what may be expected under

droughty conditions, however, some of the results obtained are of special value. In the case of celery blight in New York State, the administration has found it practicable during the last two seasons to resort to artificial inoculation under conditions where very little natural infection has occurred.

VETERINARY TESTS

The administration tested fly sprays of different compositions in order to determine their effectiveness on livestock and to find out whether or not they were injurious to animals when used as directed. The tests showed that while some of the products were efficacious as repellants for certain types of flies, such materials could not be depended upon as repellants of all types of flies which annoy animals.

Much work was done on a detailed study of demodectic or follicular mange of dogs and on the action of commercial preparations designed for treatment of this disease. Toxicity tests of products containing derris extract are now under way. Experiments on a limited number of proprietary preparations composed of several ingredients recommended for the different types of lice, ticks, mange mites, etc., on animals, are also being conducted. Because of inadequate facilities and limited personnel much needed work is delayed.

CAUSTIC POISON ACT

The country-wide survey, begun in 1928, of products subject to the caustic poison act, was completed. It is estimated that at the close of the fiscal year 1931, 70 per cent of the many thousands of labels encountered were in exact compliance with the requirements of the law.

The law now having been in operation for nearly three years and having received wide publicity, it is planned to discontinue largely the informal procedure of warning manufacturers whose labels do not meet the legal exactions and to proceed by formal action against misbranded products. During the past year 1 seizure under the caustic poison act was instituted, and 16 additional cases are in course of development.

IMPORT MILK ACT

The fiscal year ended June 30, 1931, marked the third complete year of active enforcement of the Federal import milk act, and the results achieved justify the statement that the quality of imported milk and cream has improved, and that, from the public-health standpoint, these important foods are equal to the best product of domestic origin. The work of enforcing this act is centered at Rouses Point, N. Y., in the heart of the section through which comes most of the milk from Canada, the largest exporter of milk and cream to the United States. Practically all of the foreign milk and cream coming into this country is produced in the Provinces of Quebec and Ontario, Canada. Shipments from other Canadian Provinces and some from Mexico are also entered, but these are more or less negligible in quantity.

During the past year, as a result of the farm and plant inspection work, there has been a very noticeable improvement in the sanitary condition of dairy farms and a further betterment in plant practices, both of which factors are reflected in importation of a product of uniformly high quality. Many of the plants under supervision have installed a definite farm-inspection and milk-testing system as a routine plant practice, and this has further insured a high-quality product.

The existing low prices of milk and cream, combined with effects of the increased tariff, caused a decided decrease in volume of importations as compared with that during the previous year.

The year's work included the inspection of 170 plants and 1,756 dairy farms. Products from 143 dairy farms were embargoed, and 59 foreign farms were released from a previous embargo. One hundred twenty-five permits were renewed. Station officials examined bacteriologically 2,103 samples, 99 of which showed an excessive bacterial count. Thirty-nine permits were suspended, and 18 were reinstated. Citations to hearings were issued on 30 samples, and letters of warning were issued on 56. Two thousand nine hundred and twenty-seven subdivisions of samples were examined, these consisting of 2,153 samples of raw milk, 21 of pasteurized milk, 1 of raw cream, and 752 of pasteurized cream.

An outstanding accomplishment of the year was the development of a system of physical inspection of cattle which makes possible the elimination of cows suffering from mastitis or diseased udders. Coincidental with this improvement in the inspection technic, the Rouses Point laboratory has developed definite methods for detecting mastitis in the milk from individual herds. These laboratory methods, in fact, have developed to a point where it is possible to detect milk from cows in the early stages of the disease.

TEA ACT

The Federal tea act prohibits the importation into the United States of tea that fails to meet the Government standard of quality, purity, and fitness for consumption. Every shipment of tea offered for entry is examined in the tea laboratories at New York, Boston, San Francisco, Seattle, and Honolulu.

The quantity of tea offered for importation during the fiscal year 1931 was 87,091,330 pounds, an increase of approximately 2,500,000 pounds over the importations for 1930. Of the importations during 1931, but 49,253 pounds were rejected, or 0.057 per cent of the quantity offered for entry. In comparison with the 0.245 per cent rejected in 1930, this figure indicates a progressive improvement in the quality of tea imported into the United States. Of the tea rejected in 1931, 35,000 pounds were rejected because the tea failed to meet the Federal standards for quality, and 14,253 pounds were rejected because of impurity.

New York remained the port of entry through which the bulk of tea entered the United States. Amounts received at the ports of Boston, Honolulu, and Seattle were almost identical with those received during the previous year, but there was a slight increase in the total quality offered for entry at San Francisco.

TABLE 6.—*Kinds and quantities of tea passed and rejected during fiscal year ended June 30, 1931*

Variety and station where examined	Quantity examined	Quantity passed	Quantity rejected for—	
			Quality	Purity
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Formosa Oolong.....	5, 676, 445	5, 675, 679	766	
Formosa Black.....	66, 791	66, 791		
Congou.....	1, 705, 290	1, 704, 150	1, 140	
Lapseng Souchong.....	20, 538	20, 538		
Tabloid.....	500	500		
India.....	21, 825, 325	21, 822, 090	3, 185	50
Ceylon.....	27, 280, 722	27, 276, 988	3, 734	
Blended Ceylon and India.....	571, 781	571, 781		
Java.....	7, 311, 727	7, 311, 619	108	
Sumatra.....	213, 780	213, 780		
India Green.....	117, 898	117, 898		
Ceylon Green.....	396, 750	396, 750		
Ping Suey Green.....	4, 541, 259	4, 527, 056		14, 203
Country Green.....	361, 666	361, 666		
Japan.....	14, 404, 308	14, 401, 638	2, 670	
Japan Dust.....	1, 767, 720	1, 760, 970	6, 750	
Scented Orange Pekoe.....	10, 539	10, 539		
Scented Canton.....	511, 890	507, 490	4, 400	
Canton Oolong.....	218, 929	207, 435	11, 494	
Jasmine.....	60, 266	59, 513	753	
African.....	3, 141	3, 141		
Flowery Pekoe.....	3, 894	3, 894		
Mixed.....	20, 171	20, 171		
Total.....	87, 091, 330	87, 042, 077	35, 000	14, 253
Boston.....	18, 433, 410	18, 433, 124	286	
New York.....	48, 843, 292	48, 811, 059	17, 980	14, 253
Honolulu.....	330, 587	330, 587		
Seattle.....	9, 865, 293	9, 865, 063	230	
San Francisco.....	9, 618, 748	9, 602, 244	16, 504	
Total.....	87, 091, 330	87, 042, 077	35, 000	14, 253

TABLE 7.—*Teas examined and rejected, 1916 to 1931*¹

Year	Examined			Year	Examined		
	<i>Pounds</i>	<i>Pounds</i>	<i>Per cent</i>		<i>Pounds</i>	<i>Pounds</i>	<i>Per cent</i>
1916.....	109, 536, 526	1, 768, 573	1. 614	1924.....	104, 492, 743	63, 159	0. 06
1917.....	105, 981, 158	954, 425	. 90	1925.....	92, 925, 470	84, 137	. 09
1918.....	148, 684, 384	2, 354, 277	1. 58	1926.....	98, 551, 814	457, 537	. 464
1919.....	113, 338, 535	1, 420, 568	1. 25	1927.....	97, 595, 579	100, 708	. 103
1920.....	96, 862, 858	145, 246	. 15	1928.....	91, 105, 613	57, 121	. 062
1921.....	71, 851, 847	350, 597	. 49	1929.....	93, 593, 264	115, 084	. 123
1922.....	87, 398, 221	1, 620, 162	1. 85	1930.....	84, 732, 677	207, 884	. 245
1923.....	96, 267, 920	277, 104	. 29	1931.....	87, 091, 330	49, 253	. 057

¹ The rejections are those made by the tea examiners, not the final rejections made by the United States Board of Tea Appeals.

NAVAL STORES ACT

The naval stores act provides that all rosin and turpentine shipped in interstate and foreign commerce shall be sold under standards established by the act and authorizes Government inspection and grading of naval stores at cost, upon the request of any interested person. Suitable penalties for violations of the act are provided.

Under the service features of the act, the administration maintains classifiers located in the southern producing sections in Georgia, Alabama, Mississippi, Louisiana, and Texas. These men graded, during the year, 179,630 barrels of rosin, a decrease of 16,634 barrels

as compared with the number graded during the fiscal year 1930. In addition, there was regraded, on request, at northern consuming and distributing points, 1,799 barrels of rosin. Two samples of turpentine were analyzed, on request, for interested parties. The claims or collections for this service work, returned to the United States Treasury as miscellaneous receipts, amounted to \$13,913.62, of which \$32.83 was repayment of expenses incurred by inspectors in travel. The above quantity of rosin was covered by 741 rosin classification and grade certificates, as compared with the 686 issued in 1930. The decrease in the number of barrels of rosin graded was caused by a material drop in production in Louisiana, Mississippi, and Texas, where practically all rosin made is graded by Government inspectors. There was a decided increase in the quantity of rosin graded under the act in Georgia. An interesting fact is noted in the increasing number of inquiries, concerning the grading service, which have come from producers in Florida. The State legislature, however, failed to take favorable action on the bill introduced in its last session to permit producers in that State to have their rosin graded by Government inspectors instead of by State inspectors.

A survey was made of the quality of turpentine distributed by paint and hardware stores in Washington, D. C., and vicinity. It was found that turpentine sold for general use by such stores consists almost entirely of pure gum spirits of turpentine. No evidence of the sale of adulterated turpentine or of substitutes was obtained.

Rosin shipments to northern consumers have also been closely checked. In only a few cases has serious misgrading been found. The requirement imposed by the law to show that violations are willful increases the difficulty of acquiring evidence sufficient to support prosecutions. However, two prosecutions, covering definitely willful violations of the naval stores act, and intended fraud, were terminated successfully during the year. One case consisted of arbitrary and fraudulent raising of the weight marks on rosin barrels delivered at a dock for export shipment. The other consisted of substitution, that is, delivery of wood rosin for export shipment on several contracts and invoices calling for gum rosin. Pleas of *nolo contendere* and guilty were made, and in each case the court imposed fines of \$200.

To insure the utmost accuracy in the inspection and grading certificates authorized by the naval stores act, an effort was made to increase the precision of grading rosin and to eliminate some of the difficulties involved in accurate grading by an investigation of the color of rosin by photometric methods, and also of the glass used in making rosin standard types. Spectrophotometric study of rosin showed that all rosins have a maximum transmission of radiation, or a maximum transparency, in the infra-red portion of the spectrum, at about 1,000-millimicron wave length. The transmission of light decreases with decreased wave length in a uniform manner. In the case of low-grade rosins, the absorption is complete for a $\frac{7}{8}$ -inch thickness (the standard size used for grading), in the orange portion of the spectrum, while with the high-grade pale-yellow rosins, absorption is complete at about 420 millimicrons in the blue portion of the spectrum. All rosins in a thickness of seven-eighths inch are opaque to violet and ultra-violet radiation. A further

phenomenon noted was that all rosins show well-defined absorption bands in the infra-red portion of the spectrum, between 1,000 and 2,000-millimicron wave length. Further study of this property may throw light on the molecular structure of the rosin or abietic acid molecule.

A study of the effect of dirt in rosin on its grade and color is also under way. Known quantities of fine dirt recovered from samples of so-called clean commercial rosin were added to identical samples of a rosin prepared by filtration of a rosin solution and subsequent distillation of the solvent. The change in spectral transmission was proportional to the quantity of dirt. The dirt was proved to have no effect on the hue of the rosin except at high dirt concentration, i. e., in such quantities as to render the rosin unmarketable. When this study has been extended to all grades, it is hoped that it will be possible to determine the quantity of dirt present in any sample of rosin by a single transmission measurement.

With the idea of developing an instrument to be used in the field for close-grading work, a study of the results obtained by grading rosins with a 2-filter (red-green) photometer and also with a color-comparator photometer is now under way. In the one case, brightness is measured in terms of transmission through the red-filter, and hue is recorded by the ratio of the transmissions through the 2-color filters. In the color-comparator method, the brightness of the rosin sample and of the standard are first equalized in the photometric field of the instrument, after which the color or hue value of the rosin is determined. Both methods will determine the two variables, hue and brightness, which must be taken into consideration in specifying the color and in determining the grade of the rosin.

COLLABORATION WITH OTHER BRANCHES OF THE SERVICE

Regulatory activities under the food and drugs act, and other acts enforced by the Food and Drug Administration, annually require considerable collaboration with other departments of the Government.

Collaboration with the Post Office Department during the year was of special interest and importance. The collaborative investigations unit of the Drug Control Division prepared and submitted to the Post Office Department 103 reports involving 211 analyses. These reports were submitted with a view to their consideration under the fraud law. They involved rejuvenation schemes, gonorrhea and syphilis treatments, pyorrhea, diabetes, and cancer "cures," preparations for stomach and liver troubles, gall bladder, rheumatism, and appendicitis remedies, and products recommended for use in a score of other diseases. Eye drops, claimed to be a cure for all known eye diseases, such as blindness and glaucoma, were among the articles studied.

The microanalytical laboratory examined 496 samples for 15 different governmental agencies.

The food control laboratory analyzed 4,426 samples of foods during the year for other Government agencies. These samples included more than 100 different varieties of canned and packed foods, and the work was done largely for the Veterans Administration, the Army, the Navy, and the Department of Justice.

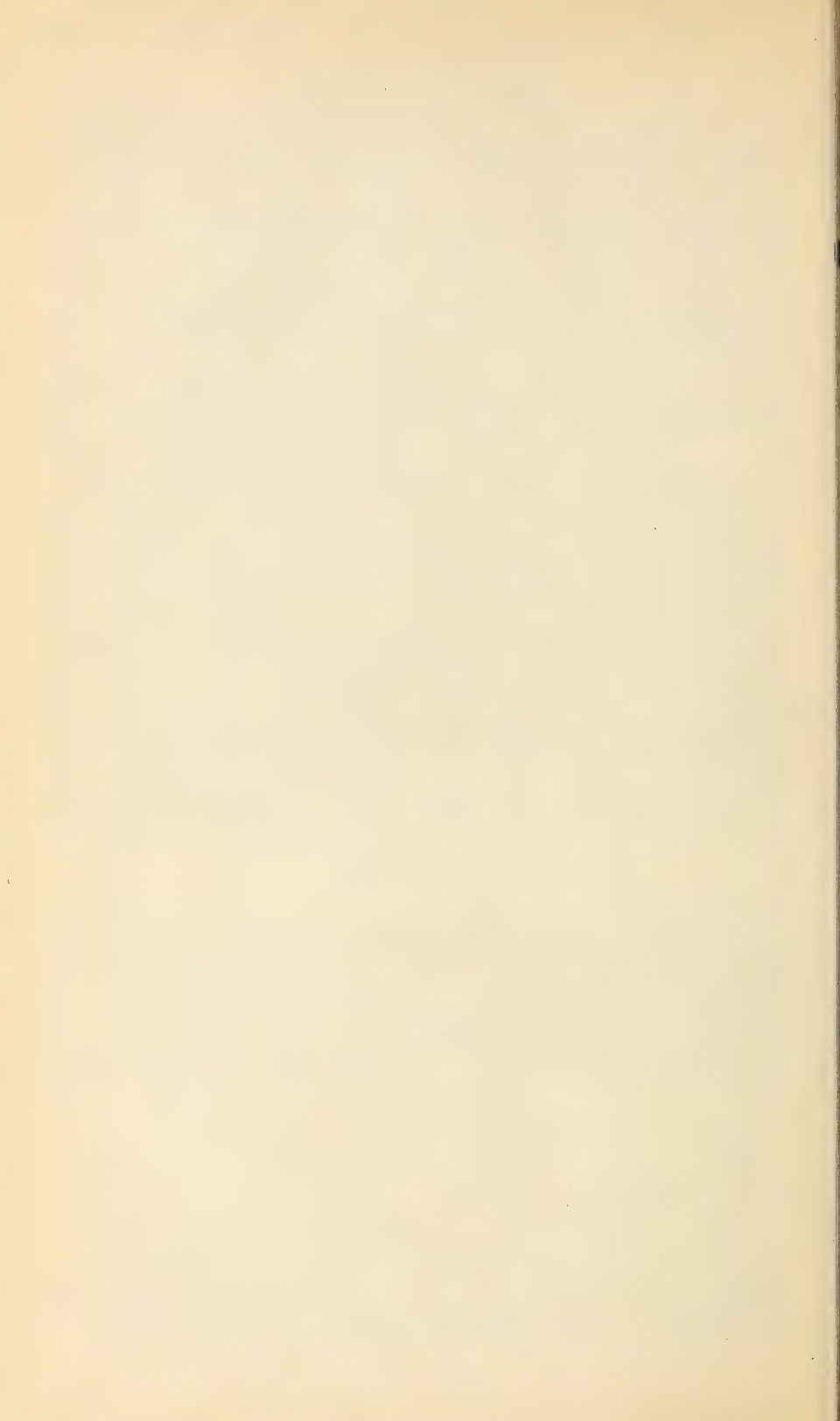
INFORMATION SERVICE

The number of inquiries received almost daily from interested and intelligent people has disclosed that after 25 years of operation there is still a woeful lack of knowledge of the requirements of the food and drugs act and of the classes of products to which it applies. Recognizing that the public can avail itself of the safeguards afforded in direct proportion to its knowledge of the law's provisions, the Food and Drug Administration, in October, 1930, organized an information service. Its purpose was to make available full information about the scope of the work done under the food and drugs act for the health and economic welfare of the public, and to disseminate for trade use announcements relating to the requirements of that law. Such knowledge enables purchasers in selecting foods and drugs to take intelligent advantage of the information borne by the labels and permits manufacturers who desire to meet the requirements of the law to comply with its provisions.

An important activity of the office during the year was the wide distribution of "read-the-label" information. In connection with the distribution of this information, two radio contacts for broadcasting talks were made, both with the National Broadcasting Co. One included an eastern hook-up of 27 stations, the other a west-coast hook-up of 8 stations. The talks were broadcast from New York City and San Francisco by representatives of the administration. Both contacts were made through the cooperation of the radio service of the department. The administration also continued to furnish the radio service with information for its Uncle Sam at Your Service syndicate program, started in a previous year. One hundred public announcements and approximately 80 magazine articles containing information of advantage to consumers or to the trade were released for technical, trade, and popular periodicals. These articles, while dealing most extensively with food and drugs act matters, covered other phases of the administration's activities.

PUBLICATIONS

Publications printed during the year included, in addition to the annual report, 1,200 notices of judgment under the food and drugs act, 25 under the insecticide act, and 1 under the naval stores act. One index to notices of judgment, Nos. 16001 to 17000, was published. Other publications of the year included Technical Bulletin 198, Circular 164, and six service and regulatory announcements. Miscellaneous Publication 48 was revised. Six articles were prepared for the 1931 department Yearbook.



REPORT OF THE FORESTER

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., September 1, 1931.

SIR: I transmit herewith the report of the Forest Service for the fiscal year ended June 30, 1931.

Respectfully,

ROBERT Y. STUART, *Forester.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

FORESTRY AND AGRICULTURE

The serious consequences that lack of economic balances and stability may produce have been deeply impressed upon the public mind during the past two years. Lack of balance and lack of stability conspicuously characterize the relationships between forest use in the United States and the forest resource. The causes are deep-seated, and the resulting maladjustment is chronic, not temporary. In this respect it bears a close resemblance to the maladjustments that afflict agriculture. Indeed, the forest problem and the agricultural problem are in many ways interrelated. Both call for foresighted planning and wisely directed public and private effort to adjust production to needs, and to bring about the utilization of our vast land resources along the lines that will contribute most to our permanent national welfare.

This is a long-time matter. A reasonably stabilized adjustment of form and manner of use to the most basic of all resources, the soil, with its enormously varying characteristics and possibilities, can take place only through a gradual advance. The advance is bound to be made, in one way or another. It may be made blindly, under a "hands-off" policy that leaves everything to economic evolution and the struggle of each man to get out of his difficulties and improve his lot as best he may. The Nation, however, is committed to a different course. It has gone far in the development of public policies and the adoption of public measures to promote efficient land use and to facilitate economic progress along lines that will make the processes of adjustment less wasteful, and more beneficial in terms of social welfare. The question is not whether foresighted planning shall be entered upon. It has been entered upon. The question is of the degree of intelligence with which it is to be carried out.

The public policies that have in view the bringing about of a more successful adjustment of the national economic life to the greatest

of natural resources, the soil, are the policies that relate to agriculture, forestry, and the public lands. Public-land policies bring in also other questions of utilization. The utilization of the mineral resources of the public lands raises questions of policy that are in the main independent of those concerning soil use. Water and soil resources, on the other hand, are so closely interrelated that they can not be dealt with independently. Long-time planning must take account of both as requiring common measures. From a long-time standpoint, public policies with respect to agriculture, forestry, and public-lands utilization, other than mining utilization, have a common goal—efficient soil use.

The land area of the United States is capable of producing agricultural products materially in excess of the present consumptive needs of the country. More land has been brought under cultivation than can be farmed, if the farming is well done, without creating burdensome agricultural surpluses. This has brought to the fore the unwisdom of enlarging further the area of cultivated land through the clearing of forest lands that have low value for agriculture. It has raised the question of restoring to use for forest production millions of acres of marginal and submarginal farm lands. Only within the last decade has public thought turned toward the idea that farming might be overdone—that its development did not imply the expansion of agriculture at the expense of the forest. Now the desire in a good many States runs the other way. Public policies are taking shape that seek to reclothe with forests both lands on which agriculture can no longer be practiced successfully and cut-over lands formerly thought to be destined for agricultural use. It is becoming widely recognized that the best interests of all, in the long run, will be best served by bringing about the use of land for whatever purpose it is best fitted for, that a great deal of land has been mistakenly cleared, and that it is a matter of large public importance to bring about the growing of forest crops as a means of utilizing lands that agriculture will not employ.

Slackening increase in population and present trends in agriculture make it clear that intensive use of our entire land area will not be necessary for a long time to come. This places us in the fortunate position of being able to locate our agriculture where production can be carried on most effectively. In the same way intensive forest production should be allocated to those portions of the remaining area where production is most effective and most needed. The residue, under proper ownership and control, can serve the needs of the Nation for water conservation, for grazing, for recreation, and in other ways, under such restrictions as will safeguard it until it is required for more intensive use. It would be wrong to assume that all forest lands can profitably be used for intensive forest culture, just as the former assumption that all tillable land could be used for agriculture has proved to be wrong.

THE PROBLEMS OF THE LUMBER INDUSTRY

Large profits from lumber operations and from increases in stumpage values in the Lake States, and to a less degree in the southern-pine region, led at the end of the last century and early in the present to the acquisition by lumbermen of large timber holdings in the

Pacific Northwest. These timberlands were derived from the public domain through the railroad and other land grants and under the timber and stone, homestead, and other general public land laws. Rapid increase in the consumption and prices of lumber in this country up to about 1907 led to the belief that this timber investment could, in a relatively few years, be liquidated at a large profit. Owing chiefly to a decrease in the rate of lumber consumption and to the unexpected continued productivity of the southern forests, this expectation has not been realized. Forest industry thus finds itself, both in the southern-pine region and in the Pacific Northwest, in possession of forest resources better adapted to permanent production than to the early liquidation upon which its plans were based. This requires a gradual readjustment of the financial basis of the industries, as well as of manufacturing and sales policies, to a long-time program. The process of adjustment necessarily creates conditions of temporary industrial instability, for which the only adequate and final cure is production based on sound land use.

In the last quarter-century our per capita consumption of lumber has been cut almost in half—without taking into account the great further decrease that has occurred in consequence of the present general business inactivity. The growth of the country in population, however, has partly offset this decrease. Lumber consumption prior to 1930 fell off only about 25 per cent from the peak year of 1906. On the other hand, pulp and paper consumption has increased. The versatility of and rapid change in modern industry now make it impossible to predict too far ahead the demand for any product. A large part of the decline in lumber consumption is attributable to severe curtailment of farm buying power. Whether the demand will increase in the eastern United States as local forests are restored to productivity can not now be foretold. Competing products have invaded the field, partly because of the efficient merchandizing methods employed in their sale and partly because of their superiority for various specific purposes. Many of the lumber substitutes are themselves made from wood fiber. Frequently these products contribute to the efficiency of wood use. The necessity of the forest industry is flexibility in production of any one product and the utmost diversification and variety in the products marketed. An effective merchandizing policy must also be an integral part of future plans.

Lumber and many of the other commodities produced from wood are of low value in comparison with their weight. This means that transportation plays a large part in the cost to the consumer, and that whenever a long freight haul intervenes, the cost to the consumer is relatively high and the producer's share of the price paid relatively small. The persistence of lumber consumption at a time when a large percentage of the supply is hauled over 2,000 miles is a remarkable economic fact. It suggests that with lower-cost production reestablished in eastern regions, wood will remain a popular commodity.

The forest-using industries provide the market for wood. Forest stabilization is tied in with their stabilization. Chief among them, of course, is the lumber industry. It has always been essentially unstable, in the sense that as an exploitative industry it has been shifting. Its individual establishments have been temporary, moving from one

location to another as new stumpage supplies became necessary; while the industry as a whole has been moving its center successively from one great forest region to another as regional depletion of the virgin timber stands dictated. It can shift no farther; its development in the great forests of the Pacific coast leaves it no new region to exploit in the United States.

Now the lumber industry is unstable for another reason. In an effort to liquidate its Pacific coast holdings at the favorable stumpage prices which had been built up, its sawmill capacity has been overdeveloped. The effort to market the output from this large plant capacity has disorganized the lumber markets of the country. There is created the dual problem of reducing sawmill capacity and simultaneously revising timber-holding policies from a liquidating to a sustained-yield basis—liquidation having proved impossible.

While industrial disorganization, market demoralization, and business instability are widespread throughout the industry, the Pacific Northwest is the main seat of the disorder. Its cause is the attempt to liquidate in a short period a resource which is undoubtedly capable of producing forever an annual output equal to the normal production of such years as 1926 to 1929. The wastage in this liquidation policy, both from the standpoint of the depletion charges involved and from the standpoint of current overproduction for the market, is proving too great a strain on the financial resources of the industry. It becomes necessary, therefore, for the industry as well as the general public to recognize that it is dealing primarily with a continuously productive resource rather than a mere store of raw material. How far-reaching the changes in capitalization, organization, and other functions of the industry will be, can not be foreseen. While there is no doubt that an excess of capital has been invested in sawmills, only time can tell whether the privately owned forest resource has been overcapitalized.

To obtain consideration of public measures that may afford relief which the lumber industry can not bring about without some form of public aid, its representatives, joined by representatives of other forest industries and of conservation organizations, appealed to the President of the United States in the spring of 1930 to create a commission of inquiry. The President some months later appointed a Timber Conservation Board, with a membership made up of cabinet officers, representatives of the lumber and other forest industries, and representatives of the general public. An advisory committee was created under this board, to assist in making an exhaustive study of the whole situation. Through representation on this committee the Forest Service is directly brought into the work.

One of the questions raised is that of the competition of national-forest stumpage, through timber sales to operators wishing to manufacture the Government timber, with private stumpage seeking a market. The cut from the national forests constitutes a very small fraction of the total lumber cut, and the policy of the Forest Service has for some years steadily aimed at avoiding the development of new large-scale national-forest operations that would tend to demoralize farther the western lumber markets. On the initiative of the President and at his express direction, this policy has been temporarily extended and made more drastic, as is set forth in

greater detail further on in this report. The whole question of the policy governing the sales made on national-forest and other federally owned land is being made a subject of special inquiry by the Timber Conservation Board.

THE PROBLEM OF WESTERN FOREST OWNERSHIP

While the objective of the lumber industry is to obtain its own stabilization as an escape from the disorganized and demoralized internal conditions due to the present overload of stumpage, its leaders for the most part recognize that permanent stabilization goes beyond that. It involves a full transition from dependence upon forests as a gift of nature to dependence upon forest crops. When that takes place land-use stabilization will have taken place.

The national-forest policy has brought the greater part of the western forest-land area, but not of the western timber now marketable, under stabilized ownership. The national parks add their quota to stabilization through Federal administration for public purposes. Land acquisition under the exchange policy will, to a minor degree, add to the western national-forest area. Western State forest policies are to some extent shifting toward retention and permanent administration of at least a part of their approximately 3,700,000 acres of forest land. Most of the nearly 7,000,000 acres of Federal forest land included in Indian reservations and all of the several million acres more of forest land still left in the open public domain have no definite policy formulated by laws of Congress which assure their stability. The crux of the western problem of permanent stabilization, however, concerns the future of the 57,000,000 acres of private forest lands, now principally held by lumber companies and other timberland owners, not with a view to permanent ownership, but as an incident to disposal, by sale or manufacture, of the removable-timber values.

The conclusion seems inescapable that much of this land will eventually revert to the States or to counties. Cut-over lands are already becoming tax delinquent on an alarming scale, in several States. Timber is one of the principal sources of western tax revenues. As the timber is cut off the value of the land is greatly lowered. A good deal of the uncut timber can not be converted into lumber with recovery of the cost involved, at the level of lumber prices that prevailed during the five years prior to the 1929 slump. There is no reason to anticipate a rise in lumber prices that will ever enable the private owners to recover their carrying charges from now to the time of cutting, on the lands of lowest value. From this source as well as through the abandonment of cut-over lands, a compulsory enlargement of public ownership is probable.

Western State policies of forestry have not yet reached a secure basis. The protection of western State and private-forest lands against fire depends for support principally on the interest and the expenditures or contributions of the landowners, supplemented by Federal cooperative funds. The States pay little more than their proportionate share as landowners, plus some overhead. As the private stands are logged the interest of the owners tends to disappear. If they drop out, their share of the cost of maintaining the

protective system is added to their tax bills—which increases the incentive to abandon title to cut-over lands. After the land passes to the State or to the counties, the burden becomes theirs. It is a very serious question whether the shifting of this burden through land abandonment will not impose a public cost which, in the face of dwindling tax receipts from private timber, the local public will not know how to meet. There is also much uncertainty as to how far the Western States will go in extending stabilized public ownership to forest areas not embraced in the national-forest system.

Under their various land grants the Western States received substantial portions of the public domain timberlands within their borders. In part these were quantity grants, but the bulk of the lands were in scattered sections. Diverse land policies have been pursued, and a number of the States have relatively little of their forest lands left. On the other hand Washington has nearly 1,400,000 acres, Idaho nearly 1,000,000, and Montana about 500,000.

It is of course impracticable to administer as permanent forest properties, small, widely scattered parcels of land. To block up the national forests and to give the States the advantage of solid holdings in place of isolated sections, land exchanges have been arranged with a number of the Western States. This process of consolidation is by no means complete, partly because of lack of inclination on the part of some of the States to obtain consolidated holdings, partly because of prohibitory constitutional provisions in certain cases, partly because plans for contemplated exchanges have not yet been carried through to final accomplishment. The largest acreages of national-forest lands in solid blocks suitable for permanent administration as State forests have been obtained by Washington, with more than 400,000 acres; Idaho, with nearly 300,000 acres; and Montana, with more than 100,000 acres. Certain other substantially blocked-up holdings place these three States in possession of some additional forest areas sufficiently consolidated to afford practical administrative units.

Montana has gone beyond any other Western State in prescribing by law for the permanent retention of its forest lands and for the establishment of specific State forest units. The legislature has created seven such units, with an aggregate area of more than 200,000 acres, and has ordained that all lands of the State principally valuable for the timber on them, or for timber growing, or for watershed protection, shall be "forever reserved." New Mexico also at one time prohibited the sale of any State forest land, but subsequently repealed the act. Washington has empowered the State forest board to set aside specific units as State forests, and also to designate as "State forest lands" and thereby reserve from sale, any lands of the State chiefly valuable for timber growing. No specific administrative units have as yet been created in Washington, but more than 1,000,000 acres have been set apart through designation. Both in Washington and in Montana sales of timber from the reserved lands must be under stipulations designed to insure forest perpetuation. South Dakota and New Mexico have laws prescribing this for their timberlands generally.

Idaho imposes similar stipulations in selling timber from its blocked-up forest lands, but this is by choice of the State's adminis-

trative officers, not by any requirement of State law. Idaho has, however, enacted no legislation looking to permanent retention of any of its forest lands. South Dakota has set aside as a State park 61,000 acres, mainly obtained through a national-forest exchange, and several other States have parks of smaller extent. In all, the 11 so-called public land Western States and South Dakota have 106,000 acres in State parks and less than 300,000 acres in organized State forest units set up by or established with the affirmative sanction of State laws. The same 12 States own, as has been already noted, about 3,700,000 acres of forest land. The national-forest area in them is nearly 133,000,000 acres.

That the Western States have progressed slowly in the formulation of policies of public-forest ownership and administration is not to be wondered at. All their granted lands were conveyed to them for specific purposes—common schools, institutions of higher education, penal and charitable institutions, public buildings, and the like. In accepting the lands the States became trustees to carry out the various purposes of the grants. To insure that the State lands should not be disposed of at too low prices, in some cases constitutional provision of a minimum sale price per acre was made. This has blocked the sale of a good deal of land, but it has not altered the obligation of the States to obtain as large returns as possible for the specific purposes contemplated by the grants. To undertake the practice of public forestry as a means of obtaining income from the lands involves a doubtful long-term commitment from the standpoint of a trustee, where the alternative of a sale of the standing timber on favorable terms is open. Considering all the difficulties and uncertainties involved in substituting forest management for forest disposal, State policies that will constitute a reasonable assurance of stabilized ownership for large amounts of salable timberlands obtained through the Federal land grants and still in the possession of the States will have to evolve gradually.

Similarly, policies of extensive State acquisition and retention of private forest lands that the owners do not wish to hold for growing future crops of timber can not be looked for as a sudden development. Local communities dependent upon the public income derived from the taxation of these lands naturally want the lands kept in private ownership if this can possibly be done. The whole theory of the past with respect to tax-reverted lands has been that they both could and should go back into private ownership. For the State to take abandoned cut-over lands and timberlands that no private owner is willing to continue to hold, block these lands up into practicable administrative units, protect them against fire, meet the other costs of administration and reforestation, and provide some equivalent to the local communities for their loss of the taxes formerly paid, will mean the assumption of very heavy burdens. In short, the problem of forest-land stabilization in the Western States is much greater than the States are prepared to cope with unaided.

The problem would be enormously greater had not the Federal national forest policy provided a stable form of ownership for the bulk of the forest land in the West. This is generally recognized. While the maintenance and in some cases the extension of the national forest system has hearty approval practically throughout the

West, from time to time proposals are brought forward that constitute a threat to the integrity of the system under the guise of advocacy of a Federal land donation from the national forests, for the benefit of some special local public need or State interest. Several such proposals have been recently advanced, and have had strong backing. If the precedent should become established of grants to the Western States of portions of the national forests for one or another special local need, movements to obtain similar grants can be looked for in fast-increasing numbers until the whole system becomes riddled and finally disintegrates, with incalculable injury to the West and the Nation.

PROVIDING WORK FOR THE UNEMPLOYED

During the winter of 1929-30 local needs for the employment of men out of work were brought forcibly home to field officers of the Forest Service, who were in touch with the situation in their immediate neighborhoods, and some relief was afforded by hastening forward construction programs already financed. In the fall of 1930 plans were again made by forest supervisors and others to carry on construction projects during the winter months. It was realized that this would exhaust the available funds before the close of the fiscal year. Ordinarily the bulk of the construction work is done in the late spring and the summer, when conditions are most favorable. In many communities, however, unemployment conditions were so critical that to provide relief during the winter was held the primary consideration.

The opportunities for providing employment were greatly increased when the act of December 20, 1930, appropriated \$3,000,000 for the construction of roads and trails for national forest protection and utilization. The money was made available to the Forest Service on December 29, 1930. The act of February 6, 1931, added \$354,800 for insect-control work and administrative and range improvements on the national forests. In addition portions of the regular 1932 Forest Service appropriations were made immediately available on passage of the agricultural appropriation act on February 23, 1931. The amounts were: \$45,000 for the control of white pine blister rust, \$40,000 for the construction and maintenance of improvements on public camp grounds, and \$494,200 for the construction of protective improvements.

As soon as it became apparent, in December, 1930, that an emergency construction appropriation probably would be available, preparation was made to expedite the work which would thus be financed. During the winter and early spring months the weather and the snow on the ground preclude efficient construction on many portions of the national forests, but so much work is needed that many planned projects can be selected which may be prosecuted with fair efficiency even in the dead of winter. The need for employment in numerous localities adjacent to the national forests was the more acute because of the drought of the preceding summer and the very sharp curtailment in employment during the preceding season in the lumbering and mining industries, while the onset of winter weather increased the suffering. Bids for furnishing a part

of the equipment that would be required to carry on the work were circulated before the emergency construction act was passed, awards were made within a few days after the appropriation was made available, and in some cases equipment was on the ground within 10 days. Final touches were given to the plans for the expenditure of the \$3,000,000 fund; and in January work was actually started in practically every State in which national forests are located, and on many projects.

By the end of January, 3,083 men had been given employment from the emergency construction appropriation. Preference was usually given to men with families, and to spread the relief more widely alternating crews were often employed. Local forest officers worked in cooperation with the Red Cross and similar organizations. In some cases the Red Cross selected the men. In February, 4,311 were given employment, and in March, 5,449—not all of them continuously, of course. April employments from this appropriation dropped to 4,754, and those in May to 4,558.

Prompt utilization of the unemployment relief appropriation was made possible by two facts. Plans were in existence calling for a large amount of construction work over a wide range of territory, and the Forest Service's decentralized form of organization provided instantly available local leadership and the necessary machinery for starting and conducting the work. Funds were allotted by telegraph to regional foresters, and similarly from them to forest supervisors. Competent executives entirely familiar with local conditions and needs were on the ground and ready with carefully matured plans for a large variety of construction projects known to be required for efficient protection and management of the national forests.

The special appropriations for unemployment relief did not inaugurate new classes of construction work, but supplemented the regular appropriations for prosecuting construction programs already under way. Consequently the funds from the two sources were intermingled, from the standpoint of activities provided for. Table 1 shows the number of employees other than those on record with the Civil Service Commission, employed for varying periods between January 1, 1931, and the close of the fiscal year, from the various appropriations:

TABLE 1.—*Number of temporary employees, by months, January–June, 1931, and appropriations from which they were paid*

Appropriation	Number of men employed in—					
	January	February	March	April	May	June
Salaries and expenses, Forest Service, 1931: Emergency construction.....	3, 083	4, 311	5, 449	4, 754	4, 558	2, 731
Highways within national forests, 1931: Emergency construction.....		192	185	103	269	135
Forest Service, insect infestations: Emergency construction.....		41	122	369	872	731
Salaries and expenses, Forest Service, 1931–32: Improvement.....		1	74	100	502	686
Sanitation and fire prevention.....				10	59	61
All other Forest Service appropriations.....	2, 133	2, 682	2, 921	7, 542	12, 078	17, 314
Total.....	5, 216	7, 227	8, 751	12, 878	18, 338	21, 658

The large increase after March from "all other Forest Service appropriations" was due principally to the employment of fire fighters in the Eastern and Lake States and in the Pacific Northwest, where an extraordinarily acute fire danger prevailed during April, May, and the first half of June. Employments in May and June also reflected the normal opening up of seasonal activities.

Because of the thousands of individual construction projects involved, their diversified nature, and the intermingling of emergency construction with that paid for from regular appropriations, it is not practicable to make an itemized statement showing separately the projects commenced or completed from emergency funds. Since it was the desire of Congress that the \$3,000,000 appropriated by the act of December 20, 1930, should be expended on roads and trails, by far the greater part of the expenditures for unemployment relief went into this form of construction. Other types of permanent improvements the construction of which was speeded up include: Telephone lines needed for fire control in localities where commercial systems are not available; permanent firebreaks placed in strategic locations to facilitate holding fires that escape from the initial efforts to control them; many-windowed lookout cabins placed on mountain peaks to house men and instruments properly located to discover lightning and other fires and transmit the alarm; lookout towers where the topography does not provide a natural elevation sharp enough to command the necessary view; dwellings, barns, and other structures necessary to provide quarters for men and animals who must be stationed remote from any settlement or rentable quarters; simple office structures for housing records and transacting public business where necessary for district rangers; fences for pastures required in administrative or fire-control work; fences to prevent the trespass of unpermitted stock or to control the drift of permitted stock in order to secure the best utilization of national-forest ranges; water improvements in the form of developed springs and wells, pipe lines, and other works required at ranger and other stations, or for watering livestock on the forest ranges, or for public camp grounds; and other camp-ground improvements designed to protect the forests, maintain sanitary conditions, and facilitate public recreational enjoyment of the forests by providing simple structures, clearing away undergrowth and inflammable material, and the like.

Two building projects of exceptional size may be mentioned as providing further for employment. The act of April 15, 1930, authorized a new building to house the Forest Products Laboratory at Madison, Wis. The agricultural appropriation act for 1931 made an initial appropriation of \$100,000, and an additional \$800,000 was provided in the 1932 act. Construction work has begun since the close of the fiscal year. By the act of March 4, 1931, \$800,000 was appropriated for the construction of buildings on Government Island at Alameda, Calif., to be located on ground donated by the city of Alameda and to be occupied by the Bureau of Public Roads, the United States Coast Guard, and the Forest Service. Difficulties incident to completion of transfer of title will prevent the beginning of actual construction before October. The buildings to be occupied by the Forest Service will serve as a central supply depot, in place of that now maintained at Ogden, Utah, and as a regional warehouse.

Reference has already been made to the fact that diminished activity in the lumber industry was one of the reasons for the severe unemployment conditions with which local forest officers had to grapple. How heavily national-forest timber sales were curtailed is shown later in this report. There is, however, something to be said on the other side. To some extent the timber resource served as a means of alleviating unemployment.

The whole nature of the national-forest enterprise makes unemployment a matter of direct concern to forest officers. The national forests are not handled primarily as business enterprises to make money, nor as conservation undertakings designed to sacrifice present welfare and present use for the benefit of coming generations. The basic purpose is to develop the potential capacity of the resources to meet human needs, and to expand use up to that capacity, always provided that the resource itself is not dissipated. A sustained yield is sought; and thus the object of management is fundamentally to promote and stabilize prosperity. In short, the national forests are in the nature of public utilities; and since the bulk of their usefulness is to individuals and communities located near them, their local managers, to function intelligently, must always have in view the service of local welfare and must study how to increase the local value of the forests as means of livelihood to those dependent upon them and as contributors to community prosperousness.

One of the principal local values of the forests is their community value as a source of opportunities for employment—sometimes directly by the Government, sometimes by private capital engaged in utilizing a forest resource, sometimes by business enterprises indirectly supported through forest use, and sometimes as an emergency resort that can be made in one way or another a temporary source of income for those out of work. It would be impossible to recount all the ways in which the national forests have contributed locally to alleviate the consequences of unemployment. An example or two, however, will serve to bring out the point.

Near Asheville, N. C., certain cuttings were contemplated on a small experimental tract within the Pisgah National Forest. Under arrangements with the associated charities of Asheville, where distress from unemployment was very acute last winter, men selected on the basis of their need for employment cut the material into cordwood. The cordwood was sold by a community wood yard in Asheville, for \$5 a cord, the proceeds going to relief work; the men were paid by a week's rations for three days' work; and the work was distributed among a considerable number of men.

In Arkansas, a forest supervisor, recognizing that dire distress was bound to follow the 1930 drought, began in the fall to offer local farmers with dependent families small sales of oak stumpage at low prices, enabling them to earn enough by cutting and selling stove bolts to subsist through the winter. Some 200 families were aided in this way. Since the quantity of suitable stumpage is small, its sale was stopped when spring came, to husband it for future occasions. On the same forest an opportunity to do some cutting to improve the silvicultural condition of the forest was used to give employment to needy local men with dependent families, at an expenditure of some \$12,000 in the course of five months. On a considerable number of forests throughout the East—indeed, wher-

ever available markets and suitable timber made the course feasible—small sales of stumpage for the production of ties, poles, acid wood, and the like were offered to local citizens who were drought sufferers or jobless, at very moderate prices, to enable them to obtain some return from working in the woods.

Unfortunately, the general business depression so reduced the market for most classes of material that relatively little could be disposed of. Nevertheless, in the aggregate the voluntary, unorganized, matter-of-course efforts of forest officers to utilize all possible opportunities to make their forests and forest activities count as agencies for ameliorating local unemployment difficulties, substantially supplemented what was done in an organized way, through use of the appropriations as already described.

COST ACCOUNTING

Throughout the business world cost accounting is recognized as an indispensable tool in effective control and coordination of effort. The modern business manager, directing the policy and operation of a large enterprise, must have records that make it possible to visualize the work and progress of the business in order that he may exercise intelligent control over its activities. The Forest Service has for a number of years recognized the need for a more adequate accounting system. The increasing complexities and widened scope of its activities had reached a point where its former system was outgrown. A better system, based on modern practice and sound accounting principles, was required to make possible a more economical use of funds and to enable management to balance accomplishment and results with costs.

The development of such a system was made a service project in 1927. It was inaugurated by means of a service-wide cost-accounting discussion course during the winter of 1927-28. The resulting conclusions and recommendations were submitted to the Forester, and in June, 1928, a committee on cost accounting met in Denver and formulated a tentative set of principles to be incorporated in the new system. The committee also outlined the mechanics of the proposed system and its application to Forest Service work.

The committee report was then submitted to all field executive officers for comment and suggestions, which were subsequently analyzed in Washington, after which, in the winter of 1928-29, the system was revised. On July 1, 1929, it was installed on 14 selected forests for purposes of experiment, development, and perfection. Its experimental use continued on the so-called "test" forests during 1930. On the basis of reports from these forests and from the regional units, submitting criticisms and recommendations, the instructions and forms were again revised and submitted to a special committee for review in the winter of 1930-31. The final draft was printed and distributed to the field in the spring of 1931, and was adopted service-wide July 1, 1931.

The installation of the system is being accomplished in two steps. Only the expenditure-record section is as yet in effect, and the cost-and-investment section will not go into effect until July 1, 1933, to allow time to absorb the work of the first section and set up the neces-

sary investment records for the second without increasing the clerical personnel.

The new system provides for the separation of expenditures and costs of revenue-producing activities from those pertaining to non-revenue activities. It also provides for the separation of expenditures of an investment nature from those of a purely expense nature and recognizes depreciation as a cost. It is designed with sufficient flexibility to meet not only current but future needs of the service and has every indication of becoming a valuable and practical administrative tool.

LEGISLATION OF THE YEAR

Most of the legislation relating specifically to the work of the Forest Service that was passed during the fiscal year—that is to say, enacted at the third session of the Seventy-first Congress—is mentioned later, in connection with the various activities affected. To facilitate an understanding of the scope and affect of this legislation in its entirety, and to provide a convenient record for consultation in later years, all the acts are listed below.

The acts making or authorizing appropriations were:

The act of December 20, 1930, 46 Stat. 1030, making supplemental appropriations to provide for emergency construction on certain public works during the remainder of the fiscal year, with a view to relieving unemployment.

The first deficiency act, fiscal year 1931, 46 Stat. 1064, approved February 6, 1931.

The second deficiency act, fiscal year 1931, Public. No. 869, approved March 4, 1931.

The agricultural appropriation act, fiscal year 1932, 46 Stat. 1242, approved February 23, 1931.

Mention should also be made of the so-called Brookhart law, act of July 3, 1930, 46 Stat. 1003, authorizing and directing the heads of the executive departments and independent establishments to adjust the compensation of certain civilian positions in the field services and prescribing certain increases in rates of salary for the classified civil service.

The acts making or authorizing changes in the area of the national forests were:

The act of July 1, 1930, 46 Stat. 841, adding an area of approximately 299,113 acres to the Boise National Forest.

The act of January 26, 1931, 46 Stat. 1040, adding an area of approximately 40,289 acres in the State of Wyoming to the Ashley National Forest.

The act of March 4, 1931, 46 Stat. 1521, adding approximately 2,991 acres to the Washakie National Forest in Wyoming.

The act of January 31, 1931, 46 Stat. 1047, transferring 34,000 acres from Rainier National Forest to Mount Rainier National Park.

The Interior Department appropriation act of February 14, 1931, 46 Stat. 1154, which included an item authorizing the President by proclamation to transfer 4,864 acres of national forest land to Yosemite National Park.

The act of February 17, 1931, 46 Stat. 1166, authorizing the President, upon joint recommendations of the Secretaries of the Interior and of Agriculture, to transfer 3,400 acres from the Powell National Forest to the Bryce Canyon National Park, and also authorizing the addition of 1,280 acres to the Powell National Forest.

The act of March 4, 1931, 46 Stat. 1518, transferring to the Wind Cave National Park, S. Dak., 880 acres within the Harney National Forest.

The joint resolution of March 3, 1931, 46 Stat. 1516, authorizing the acquisition by purchase under the Weeks Act of not to exceed 50,000 acres to be added to the Luquillo National Forest, Porto Rico.

Legislation relating to national-forest administration included:

The act of January 31, 1931, 46 Stat. 1053, providing for approach roads to national parks, and that where such roads are within a national forest the Secretary of the Interior shall secure the approval of the Secretary of Agriculture before construction begins.

The act of January 31, 1931, 46 Stat. 1052, entitled "An act to facilitate and simplify the work of the Forest Service," which authorized the Secretary of Agriculture:

(1) To hire or rent property from employees of the Forest Service for the use of other officers of the service whenever in the public interest, with limitation of the aggregate amount that may thus be paid permanent employees in any one year to \$3,000, exclusive of fire-emergency obligations.

(2) To provide forage, care, and housing for animals, and storage for vehicles and other equipment obtained by the Forest Service for the use of that service from employees.

(3) To reimburse employees of the Forest Service or other owners for loss, damage, or destruction of horses, vehicles, and other equipment obtained by the Forest Service for its use, with payment of the reimbursement from the applicable appropriations for the Forest Service; but except for fire-fighting emergencies no reimbursement amounting to more than \$50 may be made unless there was a written contract of hire or lease.

The joint resolution of February 20, 1931, 46 Stat. 1200, extending to Territories the benefits of the fire-protection provision of the Clarke-McNary Act.

Public Resolution, approved March 3, 1931, 46 Stat. 1516, authorizing the Secretary of Agriculture to cooperate with appropriate officials of Porto Rico under sections 1, 2, 6, and 7 of the Clarke-McNary Act.

The act of February 14, 1931, 46 Stat. 1115, providing that lands covered by special-use permits, in tracts not exceeding 160 acres, in the San Bernardino and Cleveland National Forests, are not subject to appropriation, entry, alienation, or adverse use unless such permit is revoked.

The act of February 16, 1931, 46 Stat. 1163, amending the act of June 2, 1930, by removing the requirement that the memorial to Theodore Roosevelt therein provided for should take the form of an archway, and eliminating the requirement that the memorial shall be completed during the year 1930.

The act of February 20, 1931, 46 Stat. 1196, authorizing the construction at Alameda, Calif., of a building required by the Bureau of Public Roads, Forest Service, and Coast Guard, and also authorizing an appropriation of \$800,000 for carrying out the provisions of the act.

The act of March 2, 1931, 46 Stat. 1468, authorizing a 10-year cooperative program for control of predatory and other wild animals on national forests and other areas of the public domain.

PROGRESS IN STATE FORESTRY LEGISLATION

Illinois passed a law authorizing Federal land acquisition for national-forest purposes; Alabama reenacted the enabling act to the same end, which its codified statutes had omitted through error; and Idaho, South Dakota, and Washington authorized counties to make over lands to the Government for additions to the national forests. The South Dakota law concerned lands acquired through tax-sale procedure, and the Idaho law contemplated the exchange of lands for Federal stumpage.

Arkansas created a State forestry commission with authority to appoint a State forester, but made no appropriation for the work; while Minnesota reorganized its conservation activities by combining under a conservation commission of five members, all appointed by the governor, the former offices of forestry and fire prevention, of game and fish, of drainage, and of conservation, together with the former functions of the State auditor with respect to the public lands, timber, waters, and minerals of the State. A commissioner of conservation, appointed by the commission, is the administrative

head of the department and appoints the directors of its four divisions—forestry, drainage and waters, game and fish, and lands and minerals. The director of the division of forestry has charge of the administration of all State forests and lands acquired or set apart for forestry purposes, of all sales of State timber, and of all State parks, and is empowered and required to classify all the State lands and determine which shall be administered for forestry and which for agricultural or other purposes.

Minnesota also strengthened and minutely detailed the provisions for the control, maintenance, and management of her State forests; withdrew from sale and added to them certain State school and other public lands; ordained that certain lands reverted to the State after a previous sale shall likewise be added; and, with a view to relieving the tax situation in certain counties and preventing default on their bonded indebtedness, authorized the acquisition of certain lands to be administered by the State for forestation, flood control, or other public purposes.

Montana authorized the exchange of State timberlands for similar lands in private ownership. This will enable the State to block up many thousands of acres of its scattered timber holdings into compact State-forest units. Delaware authorized the forestry department to acquire land for State forests, and also to sell or exchange such acquired lands when advantageous to the State's forest interests. Colorado provided for the creation of a State forest and authorized the exchange of State for Government lands. New York extended the Adirondack Park, making it the largest public park in the United States. All of the State-owned land within the park is forest-preserve land, and under the State constitution is forever protected against timber cutting. The life of the New York legislative reforestation commission was again extended for one year.

New Hampshire empowered the forestry commission to receive land for State forests and reservations, and made provision for receiving donations for forestry purposes into a fund to be disbursed in accordance with the donors' stipulations for purposes approved by the State forester. Rhode Island empowered the State commissioner of agriculture, with the approval of the governor, to accept gifts of property for general forest demonstration and experimentation purposes; provided for receiving gifts of money or securities to be used in promoting the practice of forestry on State-owned demonstration forests; and removed the limitation which had restricted the forestry expense appropriation to a small maximum amount. Rhode Island also revised its tree-warden legislation. Oregon provided that county tax-delinquent lands may be surrendered to the State, which will pay the counties 5 cents per acre annually and $12\frac{1}{2}$ per cent of all revenues from the land. Michigan provided for the establishment and management of county, township, city, village, and school-district forests, and for the sale of State lands for these purposes.

Minnesota and North Carolina authorized State forest nurseries; in Minnesota the planting stock produced is for use on State-owned lands only, but in North Carolina stock not required in the State forests may be sold to landowners. Wisconsin made it a misdemeanor to resell planting stock obtained from the State nursery.

Much State forest-fire legislation was revised. To cite only some instances: Connecticut increased the authority of the State fire warden and authorized the governor to close the woods in times of extreme fire hazard to all people except the landowners or their agents. Both Connecticut and New Hampshire made it a penal offense to throw burning substances where they may cause forest fires, and Washington required the equipment of public conveyances with receptacles for such substances. Delaware provided a fire-protective organization and gave fire wardens authority to call on any citizen to assist in fire fighting. Indiana gave the department of conservation authority to protect lands from forest fires, with payment of the cost out of the State forestry fund. Vermont altered its fire-warden legislation with a view to securing greater stability and better performance. Montana insured better fire-prevention and slash-disposal methods by requiring portable sawmill operators to obtain a license permit for each mill site on forest lands, and amended the slash-disposal law so that it can be better enforced. New Mexico required the disposal of slash and debris within 100 feet of railroad rights of way and State or county roads and made failure a penal offense. South Dakota and Nevada provided for cooperation of Federal and State agencies in forest-fire prevention and suppression. Oregon prohibited the extraction of pitch on forest land without a special permit from the State forester, and the Georgia Legislature passed a resolution calling upon judges to charge grand juries on the evils of forest fires and bring to their attention the penalties prescribed by law for illegal burning off of woods.

The Governor of Oregon was given authority to close certain areas during hazardous fire periods to all forms of use, or to make entry subject to permit involving compliance with certain regulations. The Minnesota director of forestry was authorized to prohibit or restrict the taking of brook trout in the forest areas of the State during times of forest-fire hazards, with violations punishable as misdemeanors. The Governor of Maine may now suspend the open season on hunting or fishing in time of drought for such time and in such sections of the State as he may designate; the former law made it necessary that such closing apply to the entire State. The Governor of Vermont may now close the fishing season by reason of drought in the same manner in which he was already empowered to close the hunting season. Wisconsin permits the governor to close or postpone open seasons in case of an extreme fire hazard.

In Oregon both the State and Federal Governments were given the same protection afforded to private owners against trespass for the purpose of cutting trees.

The most notable forest-tax legislation of the year was enacted by Washington. For all lands classified by the State as reforestation lands an annual-assessment value is prescribed, while the timber is maturing, of \$1 per acre if the lands lie west and 50 cents per acre if they lie east of the summit of the Cascade Mountains, with a yield tax of 12½ per cent of the market value of the timber or forest crop when cut. An amendment to the constitution making this act possible was adopted by the people at the last general election. Washington and Oregon now have very similar reforestation laws except that the Oregon law levies the tax at a flat rate of 5

cents an acre on a state-wide basis. In both States the owner is required to provide protection of the land from fire, and all lands suitable to classification as forest land come under the provisions of the law.

New York reduced from 20 to 15 acres the minimum size of tracts of land eligible for classification as reforestation land for tax purposes, and made eligible for such classification natural stands of immature timber as well as planted stands. New Hampshire readjusted the abatement of State taxes to towns containing Federal or State forest lands and discontinued their county-tax abatement. Delaware gave reforesting lands complete tax exemption for 30 years, after which the lands are made subject to the general property tax. Michigan amended its forest-tax law in several particulars, including a reduction in the yield tax from 25 to 10 per cent of the stumpage value. Wisconsin amended the 1929 law, clearing up an obscurity relative to the payment by the State to the counties of 10 cents per acre annually on county lands entered under the forest-crop law, and also passed an act to prevent the removal of timber from lands upon which tax certificates are held by the county, and which to a large extent will eventually become county forests after tax deed is taken.

The New York constitutional amendment to authorize the expenditure of \$19,000,000 for the acquisition and reforestation of land, the management of forests, and the establishment of forest-tree nurseries therefor, has passed the legislature a second time and will be submitted to popular vote at the general election this fall. Minnesota's constitutional amendment authorizing the exchange of State for Federal lands as the legislature may provide will be submitted to the electors at the general election in 1932.

WORK OF THE YEAR IN STATE COOPERATION

Federal appropriations for cooperative work with the States during the year compared with those for 1930 and 1932 are shown in Table 2.

TABLE 2.—*Appropriations for State cooperation, 1930-1932*

	Amount appropriated for fiscal year—		
	1930	1931	1932
For the prevention and suppression of forest fires and for the forest-taxation inquiry (secs. 1 to 3 of the Clarke-McNary law)	\$1,400,000	\$1,700,000	\$1,775,000
For the distribution of forest planting stock to farmers (sec. 4 of the same law)	83,000	93,000	95,000
For farm-forestry extension (sec. 5 of the law, administered by the office of cooperative extension work)	65,000	70,000	74,000

The results of the work are summarized below, except for the taxation study, which is covered on page 61. Table 3 shows in detail the Federal, State, and private funds disbursed by the States or expended under their supervision for the prevention and suppression of forest fires, and the Federal and State funds disbursed by the States for the production and distribution of planting stock.

TABLE 3.—*Cooperative expenditures for fire protection and for the distribution of forest planting stock under the Clarke-McNary Act, fiscal year 1931*

State	For fire protection				For the distribution of forest planting stock		
	Federal	State	Private agencies	Total	Federal	State	Total
Alabama.....	\$51,569.99	\$16,753.97	\$38,069.45	\$106,393.41	\$736.10	\$736.10	\$1,472.20
California.....	154,575.00	¹ 53,094.49	¹ 334,051.48	¹ 541,720.97	762.00	764.25	1,526.25
Colorado.....					1,990.51	1,990.51	3,981.02
Connecticut.....	12,963.00	70,272.38	1,712.06	84,947.44	2,000.00	2,793.83	4,793.83
Delaware.....	1,080.00	2,378.73		3,458.73	2,000.00	4,232.00	6,232.00
Florida.....	76,230.00	35,468.95	46,273.36	157,972.31	2,000.00	2,521.24	4,521.24
Georgia.....	44,670.53	17,293.42	27,377.11	89,341.06	1,400.00	1,400.00	2,800.00
Hawaii.....					4,000.00	15,918.82	19,918.82
Idaho.....	65,679.00	46,706.05	114,965.13	227,350.18	900.00	965.68	1,865.68
Indiana.....	5,500.00	5,636.98		11,136.98	3,210.00	20,737.94	23,947.94
Iowa.....					2,000.00	2,059.51	4,059.51
Kansas.....					2,165.00	5,471.00	7,636.00
Kentucky.....	16,138.70	16,138.70		32,277.40	2,120.00	2,367.11	4,387.11
Louisiana.....	48,306.00	47,222.42	43,130.12	138,658.54	1,775.78	1,775.79	3,551.57
Maine.....	54,505.00	173,932.36		228,437.36	807.83	807.82	1,615.65
Maryland.....	10,289.00	59,280.09	283.75	69,852.84	2,170.00	5,023.80	7,193.80
Massachusetts.....	30,127.00	98,505.73		128,632.73	3,090.00	5,622.65	8,712.65
Michigan.....	135,351.00	768,207.00		903,558.00	2,710.00	5,783.68	8,493.68
Minnesota.....	103,205.00	470,812.96	28,187.18	602,205.14			
Mississippi.....	32,527.96	17,598.25	14,929.69	65,055.90	311.21	311.21	622.42
Montana.....	26,819.00	16,163.42	55,197.56	98,179.98	2,479.99	5,629.80	8,109.79
Nebraska.....					3,550.00	11,802.00	15,352.00
New Hampshire.....	17,312.00	40,091.85	6,726.07	64,129.92	2,850.00	3,167.08	6,017.08
New Jersey.....	20,492.00	130,196.43		150,688.43	3,770.00	12,023.10	15,793.10
New Mexico.....	2,478.08	2,762.00	1,900.00	7,140.08			
New York.....	70,615.00	281,550.42		352,165.42	4,000.00	44,965.97	48,965.97
North Carolina.....	56,880.00	55,020.02	9,242.93	121,142.95	2,335.00	2,471.11	4,806.11
North Dakota.....					2,660.00	4,245.90	6,905.90
Ohio.....	7,162.00	21,485.17		28,647.17	3,230.00	25,820.55	29,050.55
Oklahoma.....	15,705.00	10,571.88	12,014.00	38,290.88	2,225.00	3,607.46	5,832.46
Oregon.....	104,325.00	57,566.81	223,292.12	385,183.93	1,851.23	1,851.24	3,702.47
Pennsylvania.....	51,151.00	715,123.16		766,274.16	4,000.00	18,054.88	22,054.88
Porto Rico.....					2,990.00	8,854.94	11,844.94
Rhode Island.....	2,267.00	6,631.01		8,898.01			
South Carolina.....	34,020.00	15,003.73	19,669.44	68,693.17	2,000.00	5,842.86	7,842.86
South Dakota.....	1,125.00	3,196.57		4,321.57			
Tennessee.....	23,719.00	18,334.30	7,323.14	49,376.44	2,600.00	2,929.84	5,529.84
Texas.....	39,685.00	38,226.11	14,493.51	92,404.62			
Utah.....					1,300.00	1,300.00	2,600.00
Vermont.....	7,794.00	7,545.40	3,941.95	19,281.35	2,890.00	3,661.80	6,551.80
Virginia.....	36,530.00	128,085.23	10,729.95	175,345.18	2,280.00	4,221.81	6,501.81
Washington.....	96,080.00	82,332.31	71,737.40	250,149.71	2,000.00	2,813.22	4,813.22
West Virginia.....	33,414.00	73,811.33	15,863.42	123,088.75			
Wisconsin.....	46,613.00	307,310.05		353,923.05	1,785.00	1,945.77	3,730.77
Wyoming.....					1,570.00	1,698.51	3,268.51
Administration and inspection.....	83,038.42			83,038.42	2,283.51		2,283.51
Total.....	1,619,941.68	¹ 3,910,309.68	¹ 1,101,110.82	¹ 6,631,362.18	90,798.16	248,090.78	338,888.94
Forest taxation and insurance study.....	78,740.95						
Unexpended balance.....	1,317.37				2,201.84		
Total appropriation.....	1,700,000.00				93,000.00		

¹ Incomplete. Final data for State and private expenditures in California not available at time of compilation.

Additional expenditures were made independently, by private individuals, associations, and counties; \$343,000 was reported for the calendar year 1930. The actual expenditure was much larger.

COOPERATIVE PROTECTION OF STATE AND PRIVATE FOREST LANDS FROM FIRE

In the calendar year 1930 approximately 228,000,000 acres of State and private forest or potential forest lands were reported by the States as under some form of systematic protection from fire. This was 55 per cent of the total acreage classed as needing such

protection. A gain of approximately 50,000,000 acres in the area protected has been made since 1925, of which approximately 4,000,000 acres was added during the year. Of the approximately 189,000,000 acres of forests or potential forest land which still remained unprotected, 151,000,000 acres, or 80 per cent, was in the Southeastern and Gulf States. In these States 59,000,000 acres, or 28 per cent of the total classed as needing protection, was under some form of organized protection, with a total expenditure of \$1,176,417, or nearly 2 cents per acre. The States contributed \$455,085, private owners \$251,793, and the Federal Government \$469,539.

While increased financial support for the work is badly needed, it is encouraging, in view of the business depression, that no State gave up its forest-fire-protection work last year on account of reduced available funds. The amount spent by all State and private owners was \$994,000 more than in 1929, mainly because of the extremely severe fire season in many States during the 1930 summer drought. Retrenchment in State and private expenditures for the fiscal year 1932 is in prospect.

The American Forestry Association completed, on June 30, its Southern forestry education project, conducted in Mississippi and Florida for 3 years, in Georgia for 2, and in South Carolina for 1 year. Renewal of the undertaking for another 3-year period was found to be impracticable because of the difficulty in obtaining funds during the business depression. This educational work has been a valuable stimulus to forest protection in the South.

A report on forestry and forest fires in Arkansas embodying the results of the survey mentioned in last year's annual report was transmitted to the Governor of Arkansas in August, with accompanying recommendations for the establishment of a State forest service supported by an adequate appropriation. The report was published by the Arkansas Agricultural Extension Service and received wide distribution. In the spring of 1931 a law was passed creating a State forestry commission and providing for cooperation with the Federal Government in forest protection, but no money has yet been appropriated for the work.

Cooperation with Missouri and Illinois in forest protection was temporarily discontinued. Cooperation with Porto Rico and Hawaii was made possible through an amendment of the Clarke-McNary law extending to them the provisions of sections 1, 2, and 3. A forest-fire cooperative agreement with Nevada was entered into following State legislation which opened the way for it. The work will begin in the fiscal year 1932.

The cooperating States and the district forest inspectors assigned to Clarke-McNary law cooperation in the East assisted in the revision of basic data relating to the forests of the country undertaken by the branch of research, and still under way.

The total area reported as burned by forest fires in the calendar year 1930, on lands protected by the States or the Forest Service, was 5,809,000 acres (inclusive of 1,021,000 acres of nonforest land), as against 4,876,000 acres in 1929; and on unprotected forest lands, 46,457,000 acres as against 41,354,000 acres in 1929. The data for the unprotected lands are too fragmentary and inexact to serve as more than rough estimates. Of the total area reported as burned over in the calendar year 1930, 90 per cent was nonprotected land. Within

protected units 4,788,000 acres of actual or potential forest land were reported as burned over, or 1.44 per cent of the area of such land protected. The drought resulted in unusual fire occurrence and damage during the summer months in the States most severely affected.

COOPERATION WITH STATES IN TREE PLANTING

Approximately 26,000,000 young forest trees were distributed to farmers from the nurseries of the 37 States and of Hawaii and Porto Rico cooperating under section 4 of the Clarke-McNary law. This provided for timber or windbreak planting on more than 26,000 acres of farmlands. The number of trees distributed was 2 per cent greater than in 1930.

The potential demand would justify a much greater production, were greater financial support made available. Cooperation was temporarily discontinued in Missouri and West Virginia. The Forest Service seed collection and extraction plant on the Chippewa National Forest, mentioned in previous reports, supplied to 12 States 3,985 pounds of Norway pine seed at \$4.25 a pound, 498 pounds of white pine seed at \$2.25 a pound, and 18 pounds of white spruce seed at \$6 a pound. This accomplished a material saving in seed cost.

The expenditures of Federal and of State funds during the year are shown for each State in Table 3.

COOPERATION WITH STATES IN FARM-FORESTRY EXTENSION

The establishment of young forests on the lower grades of farm land by planting nursery-grown seedlings and the management of farm woodlands so that they make increased returns are the leading projects in the broad program of farm-forestry extension for the States. In these projects 5,469 plantings for timber growing and 3,872 windbreak plantings were made during the year, and 6,010 farmers were assisted in woods management. New York and Pennsylvania continue to lead in the number of trees planted on farms. Other projects are measuring and estimating timber, protection from fire and diseases, and cutting and marketing timber products. In these 10,087 farms were reached.

Farm-forestry extension is conducted as a part of the program of the various State colleges of agriculture. Federal cooperation in this work is administered by the Extension Service of the Department of Agriculture, with the cooperation of the Forest Service. Most of the Federal appropriation of \$70,000 was used in the employment of State extension foresters, who are the leaders in the extension programs in farm forestry in the 32 States and 2 Territories cooperating under section 5 of the Clarke-McNary Act. The local field workers include county agricultural agents, 4-H club leaders, and a few home demonstration agents.

The 4-H club activities in forestry continue to show substantial increases. Thirty-one States are carrying on this type of junior forestry work with a total enrollment of 6,826 boys and 2,068 girls. Forest planting, woods care and management including fire protection, and timber estimating make up the specific projects. They were applied last year on 11,297 acres. In the Southern States the junior projects in forestry, as in all other lines, are largely based upon the

idea of money-making or investment, while in the Northern States they are more often of purely educational aim. The junior forestry work is growing relatively faster than is the senior branch of the forestry program.

NATIONAL-FOREST ADMINISTRATION

The expenditures for national-forest administration, protection, improvement, reforestation, and extension, totaling \$31,848,613.81, are shown in detail on page 80.

The appropriations of Federal funds for the national-forest enterprise in the fiscal years 1930, 1931, and 1932 are shown in Table 4.

TABLE 4.—*Appropriations of Federal funds for the national-forest enterprise, 1930-1932*

Item	1930	1931	1932
General expenses of administration, protection, and improvement.....	\$7, 527, 730. 00	\$7, 618, 460. 00	\$7, 809, 880. 00
Specifically for:			
Fire control.....	3, 450, 000. 00	1, 420, 000. 00	150, 000. 00
Improvements, tree planting, land and resource surveys, and land adjustments.....	1, 101, 050. 00	3, 210, 620. 00	2, 866, 440. 00
Land acquisition.....	2, 000, 000. 00	2, 000, 000. 00	2, 000, 000. 00
Roads and trails (construction and maintenance) needed primarily for forest protection and development.....	3, 625, 855. 89	6, 671, 023. 72	3, 496, 243. 59
Highway construction and maintenance primarily to meet public needs, as a recognition of Federal responsibility created by ownership of untaxed lands.....	4, 500, 000. 00	11, 000, 000. 00	9, 500, 000. 00

The first three items in column 2 of Table 4 are greater, respectively, by \$141,230, \$1,270,000, and \$255,120 than the corresponding sums reported last year; and the last two items are greater by \$3,000,000 each. These increases were brought about through the passage of the emergency construction act of December 21, 1930. The first item was increased by \$100,000 as the result of the emergency appropriation for insect-infestation control carried by the act of February 6, 1931, and a deficiency appropriation to take care of salary increases under the Brookhart Act added \$47,630 more. On the other hand a decrease of \$6,400 took place through a smaller final allocation of equipment and supply funds than that used in making up the statement last year.

The increase in the second item took place through a deficiency appropriation of \$1,270,000 to replenish funds drawn upon for fire-fighting expenditures in excess of the small amount appropriated in advance for this purpose. As has been explained in earlier reports, this is an established procedure, since the amount that will be required can not be foreseen and varies greatly from year to year.

The increase in the third item is made up of \$254,800 derived from the emergency construction act of February 6, 1931, and \$320 derived from the deficiency appropriation to meet salary increases under the Brookhart Act.

The difference between the amounts appropriated for 1932 and the corresponding amounts appropriated for 1931 are accounted for as follows:

The first item was increased by \$141,420 through a considerable number of minor provisions made in the regular agricultural appropriation act for the enlargement of various activities. It was further increased by \$150,000 through a deficiency appropriation of this amount, made available for blister-rust control in both 1931 and 1932, but all held for expenditure in the latter year. On the other hand, a partially offsetting decrease of \$100,000 was due to the fact that the emergency appropriation for insect-infestation control made available in 1931 under the act of February 6 of that year, as mentioned above, had no 1932 equivalent.

The difference in the second item, between the 1931 and the 1932 appropriations for fire control, is due to the method already explained, under which the costs of fire fighting are met chiefly through deficiency appropriations. The 1932 amount is the usual sum provided in advance. In point of fact, under the terms of the appropriation, two-thirds of it becomes available immediately upon passage of the act and in consequence of an unprecedentedly early beginning of the fire season in the spring of 1931 was actually all spent before the fiscal year 1932 began.

The decrease of \$344,180 in the third item was principally due to the deficiency construction increase of the 1931 item already mentioned, amounting to \$254,800. The agricultural appropriation act increased the sum provided for planting by \$25,000, for range improvements and for administrative improvements by \$20,000 each, for camp-ground improvements by \$10,000, for land adjustments \$6,480, and for resource surveys \$9,940. For protection improvements (including protection roads and trails) an addition of \$240,000 was contemplated when the agricultural appropriation bill was first drafted; but since the emergency construction legislation provided for much more extensive road building in 1931 than had previously been scheduled, the 1932 protection improvements item was reduced by \$180,800 in place of receiving the contemplated increase.

A decrease of \$174,780.13 in the 1932 provision for "roads and trails needed primarily for forest protection and development" was in consequence of the smaller receipts from the national forests in 1931, as is shown on page 82. Under a continuing appropriation, 10 per cent of the receipts of each year becomes available for road construction and maintenance the following year. The rest of the decrease in this item was due to the fact that the emergency construction \$3,000,000 added to the original 1931 appropriations for forest-development roads has no counterpart in the 1932 appropriation. In the case of the forest-highway appropriation, however, a sufficient increase was provided through appropriations made for this purpose outside the emergency legislation to make the net decrease in the final item only \$1,500,000 instead of \$3,000,000.

THE NATIONAL-FOREST PROPERTIES

The gross area of the national forests on June 30, 1931, was 185,251,582 acres, of which 24,463,895 acres were in ownerships other than that of the United States, making the net area 160,787,687 acres. During the year the gross area increased 1,275,652 acres and the net area 696,870 acres.

Area recomputations based on better surveys and land data reduced the gross area 1,237 acres; eliminations by presidential proclamations or Executive orders, 43,041 acres; eliminations by acts of Congress, 34,880 acres; and State selections under land-exchange agreements, 11,748 acres. On the other hand, presidential proclamations and Executive orders added 992,739 acres, acts of Congress 343,740 acres, land exchanges 30,029 acres, and gifts 50 acres. Table 5 shows the changes in detail.

TABLE 5.—*National-forest gross area changes, fiscal year 1931*

National forest	State	Additions	Eliminations
		<i>Acres</i>	<i>Acres</i>
Arapahoe.....	Colorado.....		¹ 14,597
Ashley.....	Wyoming.....	² 40,289	
Bitterroot.....	Montana.....	³ 152	
Black Hills.....	South Dakota.....	³ 399	
Black Hills.....	Wyoming.....	³ 289	
Boise.....	Idaho.....	² 299,113	
Chugach.....	Alaska.....		¹ 39
Crook.....	Arizona.....		¹ 118
Custer.....	Montana.....	³ 240	
Custer.....	South Dakota.....		⁴ 2,114
Deerlodge.....	Montana.....		¹ 8,319
Harney.....	South Dakota.....	³ 1,642	² 880
Hiawatha.....	Michigan.....	¹ 271,014	
Kisatchie.....	Louisiana.....	¹ 229,526	
Kootenai.....	Montana.....	³ 3,419	
Lolo.....	Montana.....	³ 740	
Marquette.....	Michigan.....	¹ 239,347	
Missoula.....	Montana.....	³ 327	
Olympic.....	Washington.....		⁴ 4,967
Ottawa.....	Michigan.....	¹ 252,551	
Pike.....	Colorado.....	² 80	
Powell.....	Utah.....	² 1,267	¹ 19,424
Rainier.....	Washington.....		² 34,000
Shasta.....	California.....	³ 160	
Sitgreaves.....	Arizona.....	³ 10	
Siuslaw.....	Oregon.....	³ 40	⁴ 846
Snoqualmie.....	Washington.....		⁴ 3,661
St. Joe.....	Idaho.....		⁴ 160
Tahoe.....	California.....	³ 7,786	
Tongass.....	Alaska.....	¹ 301	¹ 544
Umatilla.....	Oregon-Washington.....	³ 320	
Washakie.....	Wyoming.....	² 2,991	
Wenatchee.....	Washington.....	³ 327	
Whitman.....	Oregon.....	³ 14,228	
Total.....		1,366,558	89,669

¹ Made by presidential proclamation or Executive order.

² Made under acts of Congress.

³ Private lands acquired through exchange.

⁴ Made through State selections of exchange lands.

⁵ By gift.

The additions to the Ashley, Boise, Powell, and Washakie National Forests were made under specific acts of Congress. The Ashley addition involved lands important not only for timber production but also as parts of the watershed of the Hoover Dam. The Boise addition comprises important parts of the watershed of the Arrowrock Reservoir of the Boise reclamation project, where destructive erosion has affected the stream flow and caused heavy sedimentation of the reservoir. The Powell addition was a transfer from the Bryce Canyon National Park of lands not needed for park purposes, and the Washakie addition placed under management a small area of valuable timberland.

The Hiawatha, Marquette, and Ottawa additions in Michigan and the Kisatchie addition in Louisiana represent the conversion of previously established purchase areas into new national forests.

The three largest eliminations transferred lands from the Arapaho, Powell, and Rainier National Forests to the Rocky Mountain, Bryce Canyon, and Mount Rainier National Parks, and the small elimination from the Harney National Forest was transferred to the Wind Cave National Park. One elimination involved lands found not to be chiefly valuable for national-forest purposes. In Alaska two small eliminations were made to facilitate entries of lands for purposes of trade, manufacture, or residence.

Shortly before the fiscal year began the chairman of the commission on the conservation and administration of the public domain requested from the Forest Service such data as it had or could obtain regarding the unappropriated and unreserved public lands of the United States. The character of the national-forest organization and its close touch with the public lands made it possible to assemble a large volume of physical and economic data. Reports and maps were transmitted to the chairman of the commission November 8, 1930, and members of the Forest Service later appeared before the commission and presented further information. In substance, the reports of the field officers indicated that of the remaining unreserved public lands approximately 19,000,000 acres is of enough importance for timber production or watershed protection to warrant its inclusion within national forests, together with 1,900,000 acres of intermingled State and 13,600,000 acres of intermingled private lands. While more detailed studies might somewhat change the amounts, it seems evident that much land remains in Federal ownership which might appropriately be placed under national-forest management.

LAND ACQUISITION THROUGH EXCHANGE

The authority to exchange national-forest land or stumpage for State or privately owned lands within and in some instances adjacent to the national forests creates both an opportunity and a responsibility. Consolidation affords an opportunity to increase the public value of the properties and to protect and manage them more economically and effectively. At the same time exchanges can contribute materially toward solving the problems of land economy that are assuming alarming proportions in some of the national-forest regions.

Duplication of effort, uncoordinated control over integral holdings, lack of unity in utilization programs, and waste of various kinds can be greatly reduced by bringing into compact holdings the different classes of lands now of widely diffused and intermingled public and private ownerships. The national forests contain 24,463,895 acres of State and private lands. Adjoining their boundaries are additional millions of acres valuable chiefly for timber production and actually integral parts of the forest areas. Probably from 15,000,000 to 18,000,000 acres of this intermingled or contiguous land is most valuable for timber production or stream-flow conservation. Each year a considerable acreage is logged and thereupon becomes an economic, political, and social problem; economic in that to keep it

productive will involve substantial current outlays in the face of long-deferred returns; political in that its contribution toward the costs of local government is sharply reduced if not wholly eliminated, and social in that it will not for a long time help to maintain communities. The rising curve of tax delinquency carries a serious and widespread menace to local security and permanence.

Some of the Western States are moving toward programs of State-forest management, but multiplying demands upon their financial resources raise sharp question as to how far they will be able to go in undertaking the protection and redemption of the very large amounts of cut-over lands that are accumulating. Some private owners have made earnest efforts to conserve the productivity of their logged-off lands, but the economic situation is at present unfavorable to such efforts, and in numerous instances they have been abandoned. Inevitably the public interest will require placing much additional land under national-forest management, through exchange or donation. A vast problem of ways and means will arise. More liberal use of national-forest timber for acquiring land through exchange would adversely affect county finances by curtailing the amounts paid the counties out of receipts from national-forest timber sales. It seems worth while to suggest again the desirability of employing some part of the unreserved public lands, through exchanges, as a means toward meeting the problem.

Progress was made toward the consummation of two additional exchanges with the State of Michigan which will transfer to the national forests some 90,000 acres of State lands within them and give the State an approximately equal area of unreserved Federal lands adapted to State forest management. An exchange of this character can be made in Michigan under provisions of a law enacted July 31, 1912 (37 Stat. 214) relating to selection of public lands by that State. Progress also was made in further exchanges with the State of South Dakota. In Colorado the area tentatively considered for selection by the State in exchange for school sections now widely scattered throughout the national forests was cruised and appraised, but no final action was taken. The State of Montana indicated a desire to enter into further exchanges to block up its State forests. Earlier exchanges with other States were carried further by the clear listing of additional State selections.

During the calendar year 1930 reconveyances to the United States of 225,075 acres of private lands in exchange for 55,551 acres of national-forest land and 180,976,000 board feet of national-forest stumpage, valued at \$432,274, added a net 169,524 acres to the forests. The Secretary of Agriculture approved and referred to the Secretary of the Interior for further action 157 new cases, offering 304,906 acres of privately owned land in exchange for 30,890 acres of national-forest land and \$570,844 worth of national-forest stumpage. In all, to December 31, 1930, 691 land-exchange cases have been consummated. Through them the United States has acquired 1,005,598 acres of land, valued at \$4,119,299, in exchange for 291,627 acres of national-forest land, valued at \$1,538,149, and 768,563,000 board feet of national-forest stumpage, valued at \$2,096,789. Besides the net gain of 713,830 acres in national-forest area, the volume of stumpage on the acquired lands is much greater than that surrendered.

Table 6 shows the progress and results of the land-exchange work to the close of the calendar year 1930.

TABLE 6.—*Number of land-exchange cases consummated up to December 31, 1930*

State	Number	Land conveyed to the United States		Selected land granted in exchange		Timber granted in exchange	
		Area	Appraised value	Area	Appraised value	Volume	Appraised value
		<i>Acres</i>	<i>Dollars</i>	<i>Acres</i>	<i>Dollars</i>	<i>M board feet</i>	<i>Dollars</i>
Arizona.....	22	164, 278	293, 837	8, 824	19, 367	104, 479	255, 184
Arkansas.....	3	27, 448	48, 119	146	1, 030	5, 752	46, 020
California.....	73	159, 297	1, 327, 534	22, 424	447, 587	201, 763	636, 820
Colorado.....	136	64, 014	263, 052	17, 264	53, 509	54, 467	156, 929
Florida.....	11	55, 917	116, 562	21, 015	42, 181	12, 514	72, 785
Idaho.....	56	52, 686	127, 770	10, 621	51, 499	10, 142	63, 687
Michigan.....	10	61, 221	86, 597	60, 575	85, 862	-----	-----
Minnesota.....	15	2, 614	16, 298	26	16	2, 340	12, 225
Montana.....	75	119, 271	246, 950	72, 189	168, 168	21, 788	63, 157
Nebraska.....	1	8, 960	44, 800	8, 959	44, 793	-----	-----
New Mexico.....	30	66, 146	278, 098	7, 715	12, 880	106, 074	255, 122
North Carolina.....	1	71	144	1	15	-----	-----
Oregon.....	166	148, 330	937, 710	41, 460	504, 773	173, 201	364, 497
South Dakota.....	16	3, 589	13, 609	338	1, 632	1, 836	7, 144
Tennessee.....	1	14	70	-----	1	-----	-----
Utah.....	26	18, 230	110, 301	18, 307	101, 537	-----	-----
Washington.....	36	48, 577	186, 530	-----	-----	70, 969	152, 830
Wyoming.....	13	4, 941	21, 318	1, 763	3, 299	3, 238	10, 389
Total.....	691	1, 005, 598	4, 119, 299	291, 627	1, 538, 149	768, 563	2, 096, 789

LAND ACQUISITION THROUGH PURCHASE

Title was taken under the Weeks law, as amended by the Clarke-McNary law, to 594,091 acres, at a cost of \$1,869,944.27. Purchases totaling 594,090 acres and creating a total obligation of \$1,943,736.21 were approved by the National Forest Reservation Commission. The average price was \$3.55 per acre for the lands approved for purchase and \$3.15 for the lands actually acquired, as compared with a previous average of \$4.93 for all lands acquired. At the close of the year the average cost of all lands fully acquired, not including overhead, was \$4.66 per acre, the total \$18,688,536.02, and the area 4,007,386 acres, distributed by States as shown in Table 7.

TABLE 7.—*Acreage of timberland acquired in the fiscal year 1931, and total acquired to July 1, 1931, by States*

State	Acquired in 1931	Average price per acre, 1931	Acquired up to July 1, 1931	State	Acquired in 1931	Average price per acre, 1931	Acquired up to July 1, 1931
	<i>Acres</i>	<i>Dollars</i>	<i>Acres</i>		<i>Acres</i>	<i>Dollars</i>	<i>Acres</i>
Alabama.....	1, 077	5. 44	105, 747	Oklahoma.....	48, 097	1. 40	48, 097
Arkansas.....	36, 761	3. 20	283, 055	Pennsylvania.....	32, 669	8. 16	350, 003
Florida.....	112, 945	2. 87	197, 960	South Carolina.....	3, 330	4. 78	46, 820
Georgia.....	14, 489	5. 73	269, 489	Tennessee.....	2, 771	4. 24	379, 628
Louisiana.....	57, 370	3. 74	66, 983	Virginia.....	5, 287	6. 06	601, 236
Maine.....	-----	-----	33, 482	West Virginia.....	39, 645	4. 64	318, 016
Michigan.....	67, 246	1. 66	211, 973	Wisconsin.....	99, 393	1. 72	114, 999
Minnesota.....	47, 481	2. 04	115, 060	Total.....	594, 090	3. 15	4, 007, 386
New Hampshire.....	22, 038	6. 99	482, 792				
North Carolina.....	3, 491	3. 84	382, 046				

Because of inability to acquire lands under conditions acceptable to the United States, the Vernon purchase area in Louisiana, approved in February, 1928, was abandoned, and a new unit bearing the same name and in the same region was authorized instead. This unit contains a gross area of 107,000 acres, within which it is planned to acquire approximately 75,000 acres. For similar reasons the St. Croix unit, in Pine and Carlton Counties, Minn., authorized December, 1928, was replaced by the Mesaba, in St. Louis County, Minn., containing about 170,000 acres. Permanent boundaries for the Green Mountain unit, Vermont, embracing a gross area of 90,000 acres, were defined and approved, and initial purchases totaling 31,228 acres were authorized. The commission also approved additions of 12,032 acres to the Allegheny area, in Pennsylvania; 6,700 acres to the Natural Bridge area, in Virginia; and 10,819 acres to the Ocala area, in Florida; and certain extensions of the boundary of the Ouachita National Forest in Garland County, Ark. The Mackinac and Keweenaw purchase areas in Michigan were redesignated and proclaimed the Hiawatha and Ottawa National Forests.

As a means of alleviating the effects of drought and agricultural depression the commission approved early in June, 1931, an emergency program for small purchases from farmers and others wishing to sell. It thus authorized 166 separate purchases, aggregating 16,558 acres, at an average price of \$3.18 per acre and a total outlay of \$52,624.82.

An act approved March 3, 1931, extended the purchase provisions of the Clarke-McNary law to Porto Rico. This will permit of desirable additions to the existing Luquillo National Forest. The insular government has offered to donate 1,381 acres of land chiefly valuable for forest purposes.

The wisdom and soundness of the national-forest purchase policy and program initiated by the Weeks law and extended by the Clarke-McNary law seem clearly established. Lands of great public importance as sources of streams and timber supply, which would not otherwise have been protected or constructively managed, are being safeguarded from damage and deterioration and gradually brought to their highest usefulness. They are serving to stabilize dependent industries and communities and are helping to solve local problems of land economy. Their purchase has liquidated frozen assets and so promoted healthier financial conditions in their regions. The administrative and construction activities incident to national-forest management have been locally beneficial, while the Nation has obtained benefits and values commensurate with the costs. There are few ways in which the Federal Government can contribute more toward the working out of social and economic problems relating to land use.

A downward trend in land requirements for future farm crops is in prospect. The time is remote, if it ever comes, when the tillage of additional lands will be necessary. The continued cultivation of submarginal lands is now regarded as manifestly undesirable. The combined problem of submarginal farm land and cut-over or burned timberland grows in magnitude and complexity as the area of these lands increases. Their increase decreases the financial ability of

counties and States to meet the growing demands upon them, through reducing taxable assets and tax incomes. The situation is by nature difficult of successful adjustment by local agencies.

In view of all this, the proposed program of national-forest-land purchase under the Clarke-McNary law is modest. Approximately 375,000,000 acres of land east of the Great Plains are believed to be most valuable for timber production or stream-flow protection, of which 6,827,440 acres are now in Federal ownership. The program proposes an ultimate eastern national-forest area of approximately 16,000,000 acres, or 4.3 per cent of all the forest land. The State foresters have estimated the area which may eventually be included in State forests at 36,666,000 acres, or a trifle less than 10 per cent of the whole forest area, but it is far from certain that the States will be able to administer anything like this total. In any case more than 85 per cent of the forest area would be left dependent upon private initiative for its conservation and management. It is a question whether the acquisition program of the Federal Government should not be appreciably enlarged. That it should be more rapidly carried forward seems indubitable.

SPECIAL USES

The national forests serve a wide variety of miscellaneous uses, commercial, industrial, and recreational, which are compatible with their major purposes, contribute to the economic life of dependent communities and bring about a more complete utilization of the properties. Such uses are regulated through special-use permits. No charge is made for permits to public agencies or when the use is incidental to other forms of use involving a charge; but all permits issued for uses of a commercial or exclusive character involve a reasonable annual charge for the privilege conveyed. The revenues thus obtained defray the costs of administering the special-use business and contribute to the receipts made over to the counties and to the general cost of maintaining and improving the forests.

Most of the special-use permits are revocable licenses. The act of March 4, 1915, authorizes definite contracts for a term of years but for a maximum area of only 5 acres. A maximum of 80 acres would make it possible to secure in certain types of development greater facilities and better service to the public than private investors are now disposed to provide. Another obstacle is the ease with which adverse rights can be established through filing mining locations under the Federal mining laws. Within the Cleveland and San Bernardino National Forests, in California, this situation was remedied by legislation approved February 14, 1931. Similar legislation covering all national forests would promote their best utilization.

At the close of the calendar year 1930, 35,250 special-use permits were in effect, of which 16,634 were free and 18,616 subject to an annual rental charge. The free permits numbered 675 more than in the preceding year and the paid permits 375 more. The receipts totaled \$301,716.49, a slight increase.

CLAIMS AND SETTLEMENT

Where lands within national forests are involved, the reports required by the Department of the Interior as bases of action upon applications for patent under the public land laws are prepared and submitted by the Forest Service. Reports were submitted upon 128 applications for homestead patent. Of these, 115 recommended issuance of patent and 13 were adverse.

Many of the areas classified from 5 to 15 years ago as agricultural and open to entry under the forest homestead act of June 11, 1906, and the classification act of August 10, 1912, have either remained unentered or after a succession of entries and relinquishments have been left unpatented and unoccupied, demonstrating that their classification was erroneous. In the light of present knowledge, the lands clearly are not valuable for agricultural purposes. A considerable number of these listings were recalled during the year.

Of the reports upon applications for mineral patent, or upon mining locations, 80 were favorable and 30 unfavorable. The ratio of unfavorable reports points to an increasing rather than decreasing misuse of the mining laws to acquire valuable land for purposes other than mining. Since the Forest Service began to examine and report on mining claims more than 80 per cent of the reports have recommended issuance of patent. The bona fide development of mineral resources should receive every encouragement, but abuse of the mining laws should be prevented. The need for this is made more acute by the developing plans for the protection of roadside beauty. Following the survey or construction of a new State or Federal highway many mining claims have been located to obtain sites for filling stations, stores, lunch counters, resorts, and the like, or to control land or material needed for the project. Cancellation of such locations, if possible at all, necessitates the expenditure of much official time and effort. Under the prevailing liberal provisions and interpretations of the mining laws negligible indications of mineralization, plus technical compliance with the requirements for discovery and development, frequently permit the establishment of title. The most effective remedy would be so to amend the mining laws as to retain the surface rights in public ownership, subject to unrestricted use by the mineral patentee in the exploitation of mineral values.

COORDINATION OF NATIONAL PARKS AND NATIONAL FORESTS

As already noted, four transfers of lands from national forests to national parks, aggregating 68,901 acres, were made. Each of these transfers was under a specific act of Congress. The report of the Yellowstone National Park Boundary Commission, recommending transfer of 52,480 acres from the Teton National Forest to the Yellowstone National Park, awaits congressional action.

The Director of the National Park Service also has proposed for interbureau consideration transfer of the so-called Wawona area, the Devil's Postpile National Monument, Mount Banner, Mount Ritter, and the Thousand Island Lake region from the Sierra Na-

tional Forest to the Yosemite National Park; of an area embracing Buchanan Pass, Sawtooth Mountain, Thunderbolt Peak, and Apache Peak, from the Arapaho National Forest to the Rocky Mountain National Park; of the Kings River Canyon area, the Mineral King area, the Redwood Mountain and Redwood Canyon area between Sequoia and General Grant National Parks, and a square mile adjoining the latter park from the Sequoia National Forest to the Sequoia and General Grant National Parks; of the Cedar Breaks area from the Dixie National Forest to the Zion National Park; of the Diamond Lake area and the Anna Creek extension from the Crater National Forest to the Crater Lake National Park; of a part of the area situated between the Grand Teton and Yellowstone National Parks from the Teton National Forest to the Grand Teton National Park; of considerable parts of the Kaibab and Tusayan National Forests to the Grand Canyon National Park; and the inclusion of the Bandelier National Monument and related parts of the Santa Fe National Forest within a new national park. An ultimate study of the suitability for national park purposes of Holy Cross Mountain and Mount Evans, Colo., is tentatively suggested.

The proposals are receiving careful study. Many economic and social values are involved. As parts of national parks the areas would be dedicated exclusively to inspirational and educational purposes, and closed to industrial or commercial utilization. As parts of national forests the natural resources would be open to regulated use, with endeavor to provide also for coordinated utilization of all public values to the extent that available funds, authority, and administrative set-up make possible. The needs and interests of dependent local communities must be carefully weighed. To determine the form of administration which will yield the highest net return in public usefulness calls for judicial and thoroughgoing analysis of many relationships.

NORTHERN PACIFIC LAND-GRANT ADJUDICATION

The legal proceedings authorized by the act of June 25, 1929, to adjudicate the disputed questions of law and fact in relation to the land grant to the Northern Pacific Railway Co. and the equities established by the company under the provisions of that grant, were initiated by the Department of Justice during the year, and the suit has been set for hearing in the Federal court of the Eastern District of the State of Washington. The Forest Service cooperated extensively with the Department of Justice in assembling record and status data, examining and evaluating the national-forest lands involved, reviewing earlier classifications of the lands, and in other essential features of the preliminary proceedings.

PROTECTION FROM FIRE

The national forest fire record is becoming more and more significant as it lengthens. The building up of the present system of organized protection dates from 1910, the first year to bring the Forest Service face to face with the magnitude and complexity of the fire-control problem. The losses of that year were disastrous

far beyond anything ever known either before or since. Because of the extreme variations in rainfall and other weather conditions, both the difficulty of protection and the fire damage fluctuate enormously. Most of the losses take place in the extreme "bad years." Consequently statistical comparisons of successive years disclose little regarding the trend in the effectiveness of fire control. Taken as a whole, however, and considered in connection with the variable introduced by the bad years, the record begins to provide a criterion of substantial importance.

By taking the average of successive 5-year periods instead of the record of each individual year as the basis for comparison, the peaks due to the bad years are rounded off. This works well for the 15 years 1910-1924, when each 5-year period included one of the extreme bad years. The 1925-1929 period, on the other hand, included three bad years. The following comparison of the percentage of the gross area of the national forests burned over annually, by 5-year averages, for all four periods is republished from last year's report:

Per cent		Per cent	
1910-1914-----	0. 75	1920-1924-----	0. 29
1915-1919-----	. 60	1925-1929-----	. 33

It would seem a fair interpretation that the 1910-1914 average was so high because of the prodigious area burned over in the first year, when the development of large-scale organization began under the stress of an unexpected and unexampled crisis; that the progressive decline in the percentage of area burned over in the two following periods represents a gradual gain in efficiency under the unremitting effort made to master the problem; and that the rise of the percentage in the fourth period was due to the fortuitous increase from one to three in the number of bad years included.

It is a fact fully established by the weather records that the parts of the West where fire control is most difficult and where most of the great fires occur have suffered in recent years a succession of deficiencies in precipitation, with very severe summer fire conditions. The 1930 season added another bad year to the three that fell in the 1925-1929 period; and the 1931 season, still under way as this report closes, will probably be found when its record is complete to have equaled if not surpassed in the intensity of its adverse conditions the worst ever before confronted by our forest officers.

Of the 1931 area lost it is, naturally, impossible at the present time to attempt to speak except in broad, yet tentative, generalization. That it has already much exceeded the area lost in 1930 appears to be unquestionable. That, considering the conditions confronted, the performance in protection was definitely and demonstrably superior to the best performance of all the past appears to be also unquestionable. In the case of 1930 the record is complete, and ready to take its place along with those of former years. Its addition to the 1925-1929 group increases the number of years to six, and the number of bad years in the period to four. In the difficulties of control this 6-year period was beyond all comparison the worst that the Forest Service has ever gone through. The series of averages listed above may be extended by adding figures for the 6-year average, and also for 1930 singly. The showing for the gross national forest

area burned over in the last three periods of the series so extended was:

	Per cent
1925-1929, average area per year-----	0.33
1925-1930, average area per year-----	.29
1930, total for single year-----	.11

The final entry signalizes the best results in protection yet attained by the Forest Service. The percentage of the gross area burned over has in no year since 1910 been so low. Prior to 1910 a single year—1906—had a lower recorded percentage, but it was an incomparably easier year, and the small and inexperienced force of forest officers was unable in those days to record all fires. Measured in terms of damage to national-forest resources the 1930 losses were less than one-fifth of the average for the last six years. At the same time fire-fighting costs were reduced. Table 8 presents the 1930 record in the usual detail.

TABLE 8.—Comparison of fires on national forests, calendar years 1930, 1929, and 5-year average, 1926-1930

	Number of fires			Percentage of total		
	1930	1929	Average 1926-1930	1930	1929	Average 1926-1930
Class:						
Burns of 0.25 acre or less-----	4,653	4,105	3,962	55.47	55.11	55.73
Burns between 0.25 and 10 acres-----	2,246	2,040	1,937	26.78	27.39	27.25
Burns of 10 acres and over-----	1,489	1,304	1,210	17.75	17.50	17.02
Total-----	8,388	7,449	7,109	100.00	100.00	100.00
Cause:						
Railroads-----	172	290	286	2.05	3.89	4.02
Lightning-----	4,032	3,499	3,438	48.07	46.97	48.36
Incendiarism-----	1,288	786	764	15.36	10.55	10.75
Débris burning-----	278	305	246	3.31	4.10	3.46
Lumbering-----	118	123	114	1.41	1.65	1.60
Camp fires-----	715	702	680	8.52	9.43	9.57
Smokers-----	1,422	1,429	1,271	16.95	19.18	17.88
Miscellaneous-----	363	315	310	4.33	4.23	4.36
Total-----	8,388	7,449	7,109	100.00	100.00	100.00
Calendar year	Total area of national-for- est land burned over		Total damage of national- forest land burned over		Total cost of fighting fires, exclusive of time of forest officers	
	<i>Acres</i>		<i>Dollars</i>		<i>Dollars</i>	
1930-----	137,944		348,890		1,191,139	
1929-----	799,082		4,338,755		3,203,191	
5-year average 1926-1930-----	456,594		2,076,516		1,680,545	

It is believed that on an average losses will continue to shrink. Increasingly the results of the capital investment made in roads and trails are showing up. Along with this, technical skill in management and improvement in organization are steadily increasing. Technics of building the simple roads and trails which give the best service to forest protection have little in common with the construction of highways for general travel. Such roads are now constructed

at rates of cost per mile which would have been considered impossible a few years ago.

Training of the many thousands of fire guards and cooperators is being improved, so that each may function effectively when his individual competence becomes the decisive factor in determining whether a fire is quickly put out or devastates thousands of acres and must be fought for days or weeks by large, hastily organized crews. The ever-present task of impressing millions of users of the forests with the necessity for extreme care in the use of fire is being taken up along new lines, wherever new and promising lines of effort can be found, and with increased intensity of effort everywhere when the necessary funds are available. Measures are being taken to insure that before the start of each season every tool is made ready and every detail of organization and planning brought to the utmost attainable degree of preparedness. Dozens of tools and managerial devices are being employed to speed up the processes of discovering and stopping the spread of all fires. Effort is being focused on the objective of control of every fire before 10 o'clock of the morning after its discovery, regardless of how far or fast it may run initially.

The strength of the forces making for continued fire losses should not be underestimated. The weather seems to have in store an inexhaustible variety of surprise attacks with which to baffle fire executives. Such was the unprecedented spring fire season of 1931 in Oregon, Washington, Idaho, and Montana, where drought, wind, low humidity, and lightning disturbances appeared in April and May, producing a fire danger never before encountered at that time of year. Since the organization was unprepared financially or otherwise to cope with such conditions at so early a date, the forests suffered severely. Industrial, recreational, and other human uses of the forests increase rapidly, and correspondingly the number of what may be called unavoidable accidental fires. An increasing number of national-forest users and visitors come from distant parts of the country, bringing an ever-renewed stream of people ignorant of the need for care with fire and unacquainted with the precautions that are necessary not to set the forests ablaze. The slight decrease in the number of smokers' fires for 1930 as compared with the number in 1929 can not be taken as a sign of greater carefulness on the part of smokers—the fire season was shorter. Destructive logging in the remaining stands of privately owned virgin timber extend the areas of inflammable slash. The record of the next few years will add an important new chapter to the history of the struggle to conserve American forest resources.

What lies ahead in the matter of drought is of course unforeseeable. In general drought has been prevalent in the last decade. Last year the cumulative shortage of precipitation had reached such a point that on some of the western forests even tree growth was dying to an alarming extent. The 1930 shortage of rainfall in a large number of Eastern States brought about a like condition and resulted in a fire season of unprecedented severity and length. The western fire season, however, was shorter than in 1929, and there was relatively little "bunching" of lightning fires, though the total

number of lightning fires was greater than in 1929. The comparative freedom from electrical storms, which sometimes start hundreds of fires on a single national forest within a few hours, contributed much toward making the 1930 record so good.

The favorable 1930 record was, however, chiefly due to the growing number of protective improvements, increased equipment, increasing managerial skill, and increasing public interest and cooperation. Capital investment in low-cost roads and trails, while still proceeding at a regrettably slow rate, has gone far enough to make a real difference in the speed with which fires can be reached and controlled before they can do much damage. Modest increases for the employment of fire guards and other protection personnel and for tools and equipment likewise helped. The mere increase of protective funds, however, does not necessarily produce a corresponding result. Fire control is not a self-working machine into which money can be poured at one end with assurance that good results will emerge at the other. Accomplishments in an enterprise dealing with such an infinite variety of conditions of weather, climate, topography, cover, and culture must depend upon the spirit and ability of human beings. The task is so widely distributed geographically that detailed supervision becomes impossible. The ingenuity, skill, and competence of individual employees must be developed and utilized. The final result in fire control for the national forests as a whole is determined by the competence of many thousands of men, from laborers and fire guards to the regional foresters in charge, each acting under conditions which necessitate individual initiative, judgment, and knowledge. Such an enterprise presents primarily a problem in human engineering, organization, and all the delicate adjustments on which depend effective action when men are necessarily thrown on their own resources, as executives or as single fire fighters, yet must also function with closely adjusted teamwork, in a firmly controlled and at the same time swiftly operating and highly flexible unit. Without the development which has taken place along these lines the 1930 record could not have been attained. Years of effort are yielding worth-while fruit.

The cooperation of literally thousands of communities and organizations and millions of individual citizens is also contributing more and more to effective protection. The conception that the Forest Service is helping the public to protect its own forests is becoming a living reality. Without such cooperation fire prevention and suppression on the national forests could not have reached its present stage of effectiveness.

The winter of 1930-31 continued the dry cycle of recent years, with but few local exceptions. Fire weather of unprecedented severity in the early spring produced serious fires in Oregon, Washington, Idaho, and Montana. In California, the Lake States, and the East early spring fires are usual, but these regions had abnormally bad conditions. Tragic fires occurred at numerous points in the Lake States, and the national forests in that region came in for their share of trouble. Starting in most places about the middle of June, generous and repeated rains over large portions of the regions most

needing rain brought relief which for the West proved merely a breathing spell, to be followed by a summer season which, as has already been indicated, may well prove, when the fall rains permit it to be viewed in retrospect, to have been as crucial a test as the national-forest protective system has ever been subjected to. So far as can be judged at the time of concluding this report (September 1), the test has been met creditably.

USE OF RADIO ON THE NATIONAL FORESTS

The reports for 1928 and 1929 mentioned work under way to discover whether radio can be used in forest protection, as a mobile means of communication with single men or parties engaged in patrolling, scouting, trail building, or fire fighting at remote points and with shifting locations. Some authorities had advised the Forest Service that this was out of the question. Others believed the contrary. No tests of radio had ever been made that afforded a basis for actually determining whether under the special conditions involved an investment in radio equipment would be worth while. Tests to find this out were therefore initiated. The question was whether the interference from rough topography and the absorption of radio energy by trees would preclude the use of radio for the purposes contemplated.

During the field season of 1929 these tests were completed. In the nature of things, portable radio sets must be operated with low power from dry batteries in order to keep the weight of the outfit within practicable limits. It was found that while rough topography and nearness of green tree foliage do interfere very materially with transmission, this is not insuperable if the correct wave length and the most advantageous length, height, and arrangement of antenna are employed and if the portable set is sufficiently simple, sturdy, and reliable to give satisfactory results with men only slightly trained.

In carrying on the tests it was necessary to make numerous designs of radio instruments, with the result that incidentally the specifications of a portable radio set which promised to meet the requirements were produced. A model constructed under these specifications was given criticism by radio experts. A few duplicate sets were then constructed under contract, and seven were used on the Columbia National Forest during the fire season of 1930. They weighed 79 pounds each, including batteries, antenna equipment, and all containers necessary for transportation by truck or pack horse. The instruments received voice messages from a central sending station, but replies had to be by telegraphic code. Equipment for the central sending and receiving station was lent by an interested manufacturer.

The results obtained were very gratifying. At the same time they amply demonstrated the wisdom of carefully studying the needs and conditions before investing in equipment for so specialized a use. Despite difficulties on account of static, interference from a small power plant near the central station, and the unsuitability of the borrowed central-station equipment, message transmission from the

portable sets was 95 per cent reliable over distances up to 40 miles, and across the roughest topography. This degree of success in transmitting code messages from instruments operated by summer employees with only hasty and incomplete training was particularly impressive. Doubts had been expressed of the practicability of such transmission by temporary employees inexperienced both in the handling of radio equipment and in the use of telegraphic code. The doubts were unwarranted. Code transmission is not equal to voice transmission by telephone or radio, but the messages were sent with satisfactory speed and accuracy. Portable radio equipment which will send as well as receive voice is highly desirable, of course, but it is not essential.

Tests are being continued to find out whether an ultralightweight transmitting and receiving set can be developed. The present instrument serves only where truck or pack-horse transportation is practicable, as at trail and fire camps. If a set can be devised light enough for a man traveling on foot to carry in addition to food, water, and tools, it will enable a smoke chaser upon reaching a fire to call back for whatever reinforcements may be necessary. This would prevent the escape of many fires. It is also possible that a set which will transmit as well as receive voice, of about the same weight as the set already developed, can be devised. This possibility will be followed up.

The importance of radio in forest protection should not be overestimated. Radio can not compete with telephone lines for most of the communication service needed. Very few telephone lines already constructed or awaiting construction will be replaced by radio. The function of radio is to maintain communication with camps or men who for one reason or another can not be hooked up with the existing protection telephone system. Its cost may also severely limit its use. The study given the subject exemplifies, however, the established policy of watching for every development, in any field, which promises to contribute to forest protection, of investigating leads that look promising, and of creating a balanced and integrated system of protection of the highest possible efficiency from the combined standpoint of low costs of protection and minimum losses from fires.

PROTECTION FROM TREE DISEASES AND INSECTS

In the summer of 1930 a beginning was made on the eradication of wild currants from the 1,500,000 acres of white-pine producing lands within the national forests of northern Idaho, western Montana, and extreme northeastern Washington. The work was closely coordinated with similar work on near-by private lands. Funds were available only for small-scale operations. It was shortly discovered, however, that the white-pine blister rust was spreading much more rapidly than had been expected.

The economic life of this region is very largely based on its forest industries, and these industries in turn are dependent chiefly on western white pine. The regional production of white-pine products averages from \$35,000,000 to \$40,000,000. About 60 per cent of this is distributed in pay rolls. The elimination of white pine by the

blister rust would mean economic disaster to a territory as large as Maine, New Hampshire, and Vermont.

The disease attacks trees of all sizes but kills small trees faster than large ones. Both the present virgin timber and future supplies will be destroyed unless the wild currants and gooseberries, the alternate hosts of the rust, are speedily and systematically eliminated within infecting distance of the pines—900 to 1,500 feet.

After the unexpectedly rapid spread of the disease became known, plans were made for coordinated and cooperative work by the Federal Government, the State of Idaho, and the private owners, with a view to covering the area needing protection in 10 years, instead of in 20 as was previously contemplated. For the season of 1931 the work on national forests was expanded, with funds made available by a deficiency appropriation, to the extent for which trained and competent personnel were available. Further expansion of the work is essential if the national forests of the region are to accomplish the purposes for which they were set aside, and are to furnish a continuous supply of usable wood for the local manufacturing industries and their dependent communities. The currants and gooseberries should be eradicated from at least 200,000 acres of the Government white-pine land each year (allowing for lands which will have to be cleaned a second time) under the economical and effective methods developed by the research work of the Bureau of Plant Industry.

The disease has not yet reached the important sugar-pine-producing portions of California, but it is known that this tree, like the other American 5-needled pines, is susceptible.

Direct control of insects on the national forests is required chiefly for the protection of grown timber. The bark beetles, which cause the greatest losses, normally attack trees of merchantable size. The protection of present values, either in the form of loggable stands or in the form of scenic attractiveness, rather than provision for the growing of future crops, is usually the aim. Tree-killing insects rarely destroy the productive power of a forest directly, though they are often an important factor in the creation of barren areas, because the masses of dead trees which are the aftermath of a severe insect infestation constitute a serious fire danger for many years.

The control of bark-beetle epidemics on the national forests was centered on the areas where the largest values were imperiled. The epidemic in the western white pine on the Coeur d'Alene National Forest, in Idaho, broken on some of the areas by the work done in the spring of 1930, had to be further fought to prevent reinfestation from missed broods and from territory not reached previously. A small amount of similar "mop-up" work was done in western white pine on the near-by Clearwater Forest and more on the Kootenai Forest, in northern Montana. The largest project, however, was in the lodgepole pine on the national forests near or adjacent to Yellowstone National Park, coordinated with work within the park boundaries by the National Park Service.

New centers of infestation were found on or near the Madison National Forest in Montana, the Targhee Forest in Idaho, and the Teton and Wyoming Forests in Wyoming. Both fall and spring work was done, in spite of difficulties due to mud and high water in the spring and to snow in both seasons. Pack-animal transporta-

tion, with the fording of mountain streams during spring freshets, was necessary in some cases, as on the Grays River project in Wyoming, where centers of infestation were scattered along 45 miles of a mountain-bordered, roadless valley. The work was of material aid in relieving bad local unemployment conditions. Heads of families were given preference.

The organization and effective supervision of a large insect-control job puts a strain on the regular local administrative force comparable only to that caused by a bad fire season. The employment, transportation into remote areas, sheltering, and supporting of hundreds of laborers takes precedence over other work and necessitates its postponement to meet the emergency. Insect epidemics occur irregularly on any one forest or in any one region, and no permanent organization for handling them is feasible. Insect-control projects are emergency protective jobs, often to be done under difficult climatic and transportation conditions.

Relatively small control projects were undertaken in Oregon and in California against another species of bark beetle, which attacks chiefly western yellow pine. One of these projects was in cooperation with the National Park Service to eliminate an infestation partly within the Yosemite National Park and partly on the adjoining national forests. On another, in Oregon, the active cooperation of the owner of adjacent private lands was obtained. An area adjacent to the Crater Lake National Park was cleaned of infested lodgepole pine as part of a cooperative project involving chiefly park lands.

Most effective cooperation was maintained with the Bureau of Entomology throughout the year. The advice of the experts of that bureau was freely sought and cordially given. This advice and assistance was of direct and material help in obtaining effective and economical results.

Examinations showed that the work done on the Colorado National Forest, mentioned in last year's report, had been successful and that no additional effort was necessary in 1931. On the Nebraska National Forest the parasites introduced by the Bureau of Entomology continued to reduce the tip-moth damage to the plantations. At the close of the year there were strong indications that a serious bark-beetle epidemic was building up in the western yellow-pine stands in California. The attacking species has two generations each season, so that the degree of infestation in different places can not be determined until late in the fall. Arrangements have been made for collecting the necessary information in cooperation with the Bureau of Entomology.

TIMBER

The business depression was reflected in a reduction in the cut under national-forest timber sales from 1,488,096,000 board feet in the previous year to 1,052,616,000 board feet—about the same amount as was cut in 1925. The reduction was greater where, as on the Pacific coast, most of the manufactured product goes into the general market than where most of it is used locally, as for example in the central Rocky Mountain region; but some decrease occurred in all

regions except in the Lake States, and the increase there was insignificant.

The falling off in the cut of national-forest timber under sales appears to have been about proportional to the lessening of activity in the lumber industry of the country as a whole. Additional timber, amounting to 171,455,000 board feet, approximately the same as in the previous year, was cut under land-exchange agreements. As has been pointed out in previous reports, the cutting of timber under exchanges represents essentially not the marketing by the Government of public stumpage but the liquidation of private stumpage and a shift in the location of the national-forest holdings, since in the course of a year the standing timber on the lands transferred to public ownership at least equals the amount made over to the private owners.

The reduction in receipts from timber sales was more, proportionately, than the lessening in cut. This was due partly to the shutting down of operations or to very small-scale operations by holders of long-term contracts for relatively high-priced timber, and partly to a decrease in advance payments. Some companies continued to cut until they had taken all the timber covered by their advance deposits, and then shut down. Others continued to operate, but on a reduced scale, making advance payments in smaller amounts than in previous years, so that the sums to their credit at the close of the year were smaller than at the beginning. In consequence the value of timber delivered during the year exceeded by \$383,512 the receipts from sales. The advance deposits on hand at the end of the year were cut down in equal amount.

Near the close of the year the long-standing policy of not offering large sales of timber for new sawmills was reaffirmed and extended by direction of the President. This policy was first inaugurated because the productive capacity of the already-existing sawmills has been steadily in excess of the needs of the country for lumber, leading to overproduction. It is recast with more rigid definition as an assurance to the lumber industry that during the period of depression, which has greatly augmented the very serious difficulties of the industry, national-forest timber will not be sold to supply needs that private stumpage is available for. Public announcement of the reaffirmed policy was made as follows:

No sales of national-forest timber will be made during the present economic situation where the value of the timber is in excess of \$500, except under the following three enumerated conditions:

(1) To supply the needs of already-existing sawmills which are dependent upon the national forests for their raw material and where such raw material can not be obtained elsewhere.

(2) To furnish domestic paper mills with raw material needed to supply the domestic market with newsprint and other wood-pulp products.

(3) To dispose of wind-thrown, fire-damaged or fire-killed, and insect-infested timber.

This policy protects the users or manufacturers who are dependent upon a stable supply of timber from the national forests, but removes any possibility of the crowding of lumber from new enterprises supported by national-forest stumpage, on a market already fully supplied. The exception in regard to sales of pulpwood is due to

the importation, as pulpwood, wood pulp, or paper, of over half of the pulp products consumed in the country. The use of American wood in American mills for the manufacture of a larger proportion of the country's newsprint and other papers would employ American labor and would utilize American natural resources. It is not expected that large sales to salvage dead or damaged timber, under the third exception, will be necessary.

The awards of the large sales of pulpwood in Colorado, mentioned in last year's report, were allowed to lapse by the highest bidder, in view of the general business conditions. The availability of spruce and true fir in the Rocky Mountains, as well as of hemlock and spruce in Alaska, is now well known, however, and will inevitably lead to the utilization of these national-forest pulpwood resources.

Conditions in the lumber industry led to the adoption of a liberal policy of extensions of contracts and of reducing the amounts required to be cut during specific periods. For example, one company which has contracts for timber to supply three separate mills wished to operate only two, and was given an extension of the time within which the contract required that timber intended for the third mill must be cut in a specified amount. Thus holders of contracts were under no pressure to add to the existing supply of lumber by continuing operations merely in order to meet the time requirements of their agreements.

The national-forest timber-sale business for the calendar year 1930 is summarized in Tables 9, 10, and 11.

/ TABLE 9.—*Number of national-forest timber sales, classified according to amounts of sale, by States, calendar year 1930*

State	\$500 or under, commercial sales	\$500 or under, cost sales	Total	\$501 to \$1,000	\$1,001 to \$5,000	Over \$5,000	Total
Alabama.....	1		1				1
Alaska.....	196		196	6	7	2	211
Arizona.....	1,208	190	1,398	4			1,402
Arkansas.....	67	54	121	1		2	124
California.....	563	245	808	2	11	12	833
Colorado.....	787	261	1,048	5	14	5	1,072
Florida.....	152		152		2	1	155
Idaho.....	939	1,365	2,304	8	18	9	2,339
Michigan.....	42		42				42
Minnesota.....	223		223	1	2	3	229
Montana.....	683	1,156	1,839	7	7	4	1,857
Nebraska.....	40		40				40
Nevada.....	68	113	181				181
New Hampshire.....	197		197	2	5		204
New Mexico.....	1,195	621	1,816	2	3	2	1,823
North Carolina.....	328		328		6	3	337
Oklahoma.....	19		19				19
Oregon.....	684	488	1,172	4	5	8	1,189
Pennsylvania.....	8		8	1			9
South Dakota.....	448	74	522		7	4	533
Tennessee.....	293	3	296	6	5	2	309
Utah.....	320	534	854	1	1		856
Virginia.....	357		357	1	2	1	361
Washington.....	274	77	351	4	6	13	374
West Virginia.....	24		24		1		25
Wyoming.....	335	229	564	2	1	1	568
Total, 1930.....	9,451	5,410	14,861	57	103	72	15,039
Total, 1929.....	8,330	5,230	13,560	75	122	107	13,864

TABLE 10.—Quantity and value of national-forest timber sold, calendar year 1930

State	Quantity sold			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	<i>Board feet</i>	<i>Board feet</i>	<i>Board feet</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Alabama.....	10, 000	-----	10, 000	45	-----	45
Alaska.....	40, 870, 000	-----	40, 870, 000	70, 647	-----	70, 647
Arizona.....	8, 705, 000	295, 000	9, 000, 000	17, 937	311	18, 248
Arkansas.....	7, 236, 000	188, 000	7, 424, 000	39, 835	192	40, 027
California.....	114, 802, 000	1, 345, 000	116, 147, 000	304, 781	1, 058	305, 839
Colorado.....	255, 587, 000	872, 000	256, 459, 000	531, 777	945	532, 722
Florida.....	6, 260, 000	-----	6, 260, 000	44, 052	-----	44, 052
Idaho.....	157, 735, 000	4, 046, 000	161, 781, 000	516, 541	3, 673	520, 214
Michigan.....	1, 551, 000	-----	1, 551, 000	3, 111	-----	3, 111
Minnesota.....	263, 896, 000	-----	263, 896, 000	550, 553	-----	550, 553
Montana.....	28, 243, 000	4, 480, 000	32, 723, 000	85, 826	4, 667	90, 493
Nebraska.....	58, 000	-----	58, 000	180	-----	180
Nevada.....	1, 871, 000	296, 000	2, 167, 000	1, 631	261	1, 892
New Hampshire.....	4, 817, 000	-----	4, 817, 000	19, 329	-----	19, 329
New Mexico.....	231, 470, 000	924, 000	232, 394, 000	455, 716	1, 005	456, 721
North Carolina.....	23, 456, 000	-----	23, 456, 000	52, 271	-----	52, 271
Oklahoma.....	167, 000	-----	167, 000	251	-----	251
Oregon.....	126, 983, 000	2, 272, 000	129, 255, 000	349, 423	1, 576	350, 999
Pennsylvania.....	1, 027, 000	-----	1, 027, 000	1, 800	-----	1, 800
South Dakota.....	23, 127, 000	204, 000	23, 331, 000	71, 089	263	71, 952
Tennessee.....	17, 723, 000	5, 000	17, 728, 000	31, 058	6	31, 064
Utah.....	7, 102, 000	1, 071, 000	8, 173, 000	13, 044	1, 134	14, 178
Virginia.....	26, 840, 000	-----	26, 840, 000	37, 064	-----	37, 064
Washington.....	1, 990, 210, 000	251, 000	1, 990, 461, 000	6, 528, 528	173	6, 528, 701
West Virginia.....	555, 000	-----	555, 000	1, 791	-----	1, 791
Wyoming.....	12, 994, 000	873, 000	13, 867, 000	31, 719	758	32, 477
Total, 1930.....	3, 353, 295, 000	17, 122, 000	3, 370, 417, 000	9, 760, 599	16, 022	9, 776, 621
Total, 1929.....	1, 032, 068, 000	18, 826, 000	1, 050, 894, 000	3, 298, 527	17, 283	3, 315, 810

¹ In addition, minor products not convertible into board feet were sold, value \$41,704.

² In addition, minor products not convertible into board feet were sold, value \$50,010.

TABLE 11.—Quantity and value of national-forest timber cut under sales, calendar year 1930

State	Quantity cut			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	<i>Board feet</i>	<i>Board feet</i>	<i>Board feet</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Alabama.....	16, 000	-----	16, 000	66	-----	66
Alaska.....	44, 957, 000	-----	44, 957, 000	80, 685	-----	80, 685
Arizona.....	50, 206, 000	270, 000	50, 476, 000	115, 873	292	116, 165
Arkansas.....	24, 850, 000	194, 000	25, 044, 000	164, 815	199	165, 014
California.....	318, 714, 000	1, 291, 000	320, 005, 000	975, 673	976	976, 649
Colorado.....	53, 778, 000	825, 000	54, 603, 000	130, 878	927	131, 805
Florida.....	3, 848, 000	-----	3, 848, 000	13, 607	-----	13, 607
Idaho.....	100, 726, 000	4, 141, 000	104, 867, 000	415, 919	3, 846	419, 765
Michigan.....	1, 847, 000	-----	1, 847, 000	3, 880	-----	3, 880
Minnesota.....	13, 640, 000	-----	13, 640, 000	45, 276	-----	45, 276
Montana.....	33, 178, 000	5, 129, 000	38, 307, 000	99, 239	5, 433	104, 672
Nebraska.....	53, 000	-----	53, 000	177	-----	177
Nevada.....	997, 000	269, 000	1, 266, 000	1, 545	242	1, 787
New Hampshire.....	15, 869, 000	-----	15, 869, 000	101, 964	-----	101, 964
New Mexico.....	14, 786, 000	907, 000	15, 693, 000	31, 459	920	32, 379
North Carolina.....	14, 017, 000	-----	14, 017, 000	39, 347	-----	39, 347
Oklahoma.....	167, 000	-----	167, 000	251	-----	251
Oregon.....	196, 209, 000	2, 464, 000	198, 673, 000	495, 527	1, 721	497, 248
Pennsylvania.....	4, 023, 000	-----	4, 023, 000	13, 418	-----	13, 418
South Dakota.....	41, 284, 000	224, 000	41, 508, 000	159, 602	295	159, 897
Tennessee.....	6, 435, 000	32, 000	6, 467, 000	14, 682	32	14, 714
Utah.....	12, 323, 000	969, 000	13, 292, 000	27, 107	1, 009	28, 116
Virginia.....	15, 159, 000	-----	15, 159, 000	41, 186	-----	41, 186
Washington.....	212, 765, 000	168, 000	212, 933, 000	471, 760	119	471, 879
West Virginia.....	509, 000	-----	509, 000	1, 766	-----	1, 766
Wyoming.....	56, 780, 000	944, 000	57, 724, 000	153, 337	948	154, 285
Total, 1930.....	1, 237, 136, 000	17, 827, 000	1, 254, 963, 000	3, 599, 039	16, 959	3, 615, 998
Total, 1929.....	1, 402, 275, 000	18, 913, 000	1, 421, 188, 000	4, 086, 086	16, 933	4, 103, 019

¹ In addition, other products not convertible into board feet were cut, value \$22,142.

² In addition, other products not convertible into board feet were cut, value \$18,134.

PLANTING

The development of planting on the national forests east of the Great Plains was continued. A new large nursery was started near Rhinelander, Wis., on land donated for the purpose. This nursery will supply trees for reforesting areas denuded by past fires and cutting on the lands being purchased for national-forest purposes in Wisconsin and in the near-by portion of Michigan. The nursery at Russellville, Ark., was enlarged to produce 1,000,000 seedlings annually, for use chiefly in reforesting abandoned fields in the Ozark National Forest. These nursery developments were authorized by the Knutson-Vandenberg Act of June 9, 1930, with the expectation that the fiscal program for national-forest planting will be carried out by appropriations in subsequent fiscal years as authorized by that act. This program will bring the planting activity into balance with other activities on the eastern national forests, but not on the western. Purchases by the National Forest Reservation Commission are constantly adding to the area of eastern national-forest land needing to be planted. The strategic location and potential productivity of the eastern forests make it wise to increase operations in that part of the country as additional funds become available under the present limited fiscal program, and to defer the enlargement of operations in the West, although many large old burns, some of them antedating the setting aside of the forests from the public domain, must remain unproductive until their artificial reforestation can be provided for.

Planting requires planning years ahead. First the area which it is proposed to plant is examined to determine what portion of it, if any, may be expected to become timbered by natural seeding, and the exact area which must be planted if it is to have a timber crop restored. The species and sizes of trees best suited to the particular sites are determined, and the work of planting is mapped out by seasons or years, with due regard for transportation facilities, suitable camp sites, and other matters on which depend the economy and efficiency of the work. The planting is then assigned to definite years in the future. There follows the collection of tree seeds of the right species and varieties, in the quantities necessary to produce, in the nursery, the number of young trees needed. From two to four seasons are required to grow the trees in the nursery to the right size and condition for planting on the specific sites to which they were allocated. Thus each year the actual setting out of the young trees is the culmination of several years of carefully planned work. In many cases over half of the cost is incurred in collecting seed and growing the trees in a nursery, in years previous to the actual planting. No sudden expansion of the acreage planted is ordinarily possible. Only when and to the extent that suitable nursery stock can be purchased from State or private nurseries having surpluses can planting on national forests be expanded to meet temporary emergency conditions such as widespread unemployment.

Planting is done in the spring as soon as the melting of the snows permits, or in the fall after the first heavy rains, but before snow covers the ground. The opportunities for temporary jobs in planting crews are welcomed by many farmers, who thus prolong the season of work. Frequently owners of small farms or ranches return year after year to work for a month or six weeks in the planting camps

on some national forest, and have come to count on the wages so earned as an essential part of their income. These selected, experienced men need less training and supervision than do those unfamiliar with the conditions and methods. Many are heads of families, and the extension of their working season, especially in the spring of 1931, was welcomed as a means of family support.

This was especially true within the region which suffered from the 1930 drought. The national forests in West Virginia, Arkansas, Michigan, and Nebraska were within the drought area, and in employing planting labor, care was used to give as effective relief as possible.

Within the drought region recent plantations on some forests suffered severe losses. This was particularly true of the national forests in Nebraska and Michigan. In other places, as in West Virginia, local showers in the mountains were sufficient to keep the trees alive over the drought period. On the Bessey division of the Nebraska National Forest and on the Huron Forest in Michigan considerable areas planted in the spring of 1930 had to be replanted in the spring of 1931 or still remain to be replanted.

In the fall of 1930 trees suitable for planting were produced for the first time from the nursery at Susanville, Calif., and from the area added to the nursery at East Tawas, Mich. This new production was made possible by the act of March 26, 1929, which authorized the purchase of the sites. The enlarged supply permitted an increase in the total acreage planted from 18,196 acres in the calendar year 1929, to 21,702 acres in 1930, with an additional 5,037 acres partially replanted. Increased output from the additions to the nurseries at Monument, Colo., and Halsey, Nebr., made under the same legislative authorization, will begin in 1932 or 1933.

During the year the accumulated experience of 20 years of nursery work was made available to the public by the publication of a circular, *Growing Trees for Forest Planting in Montana and Idaho*. It contains descriptions of the machines and methods developed at the Savanac nursery in Montana. The adaptation of these devices to diverse conditions will help to decrease the cost of national-forest planting in all regions, and of planting-stock production by other agencies.

The areas planted and sown in the calendar year 1930 are shown, by States, in Table 12.

TABLE 12.—*Planting and sowing on national forests, by States, calendar year 1930*

State	Area planted	Area sown	Total	State	Area planted	Area sown	Total
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>		<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Michigan.....	8,452.50	-----	8,452.50	Wyoming.....	214.30	-----	214.30
Idaho.....	4,166.96	-----	4,166.96	Florida.....	165.10	-----	165.10
Wisconsin.....	1,500.00	-----	1,500.00	Arkansas.....	73.00	-----	73.00
Colorado.....	1,486.49	-----	1,486.49	New Hampshire.....	67.40	-----	67.40
Nebraska.....	1,173.01	-----	1,173.01	Tennessee.....	62.50	-----	62.50
Washington.....	924.00	-----	924.00	Virginia.....	38.20	-----	38.20
Minnesota.....	856.70	-----	856.70	Utah.....	19.75	-----	19.75
Montana.....	790.00	-----	790.00	Nevada.....	4.00	-----	4.00
Pennsylvania.....	548.00	-----	548.00	Oklahoma.....	3.00	-----	3.00
Oregon.....	535.00	-----	535.00	North Carolina.....	1.50	-----	1.50
West Virginia.....	312.70	-----	312.70				
California.....	307.91	12.00	319.91	Total.....	21,702.02	12.00	21,714.02

¹ In addition 5,037.5 acres in Michigan and Minnesota were partially replanted.

RANGE

Throughout the western range States the spring of 1930 was unusually dry. Forage failed to make its normal growth, and unusual damage to the range might have occurred had not some feed been left on the ground from the previous year. This tided the situation over until, in late July and August, rains fell pretty generally in all regions. The forage then made a rapid growth, and while the production was below normal, stock came off the national-forest ranges in fair condition.

As usual in drought periods, outside ranges were more seriously affected than those within the national forests. The most critical situation arose in Montana, where urgent demands were made for increased grazing privileges on the national forests. At the risk of a temporary overstocking, relief was provided for 151 cattle and horse raisers and 64 sheep owners whose outside ranges had failed, through increases that allowed 5,691 cattle and horses to graze for two and one-tenth months and 78,413 sheep for three-quarters of a month.

The ability of national-forest ranges to withstand long periods of drought better than ranges not under regulation does not justify an expectation that it can regularly meet the increased demand created by a shortage of forage on private or uncontrolled range. To the extent that range conservation permits, the Forest Service stands ready, and desires, to assist in times of emergency; but a permanent solution of the problem must be accomplished in a different way. The principles of conservative use practiced on national forests are equally applicable to outside ranges. Stockmen would do well to safeguard themselves against emergencies due to feed shortage by seeing to it that some forage is always left on private ranges at the close of the season. This can be done by limiting operations to the number of stock that can be carried during subnormal seasons and by adopting other well-tried, improved practices.

As a rule, the deficiency of precipitation in 1930 followed and was made more serious by several years of previous shortages. The desirability of a further adjustment in range capacities has now become fully manifest.

Considering the general business situation, market prices on cattle held up exceptionally well throughout 1930, but market values of sheep continued to decline. There is strong evidence that retrenchment in operating expenses has materially affected the management of sheep on the national forests. Reductions in wages naturally tend to result in a lower quality of services. It is appreciated that periods of depression force operators to drastic economies, and whatever loss of efficiency in range management last year was due to that may be charged up as a public contribution to the efforts of stockmen to make income and expenditures balance.

The necessity of reducing operating expenses also brought about an urgent demand for a reduction in grazing fees. With a full appreciation of the unfavorable market conditions and the laudable efforts of stockmen to make their business pay, the Forest Service believes that the maintenance of a permanent policy with regard to the amount of the fees and the manner in which they are to be paid is of far greater importance to the industry than any temporary

benefits which might accrue through their reduction or through a departure from the prescribed method of payment. The Forest Service is committed to a fair and reasonable fee, fixed in amount for a rather long period. It was and is appreciated that fluctuations in the market prices of livestock products will occur in the future, as they have occurred in the past. Approval of the request of stockmen at this time would, in the interest of consistency, dictate an increase in fee under favorable conditions. This would lead to endless controversy. The fee now being charged is below the price paid for comparable range by those not privileged to graze on the national forests. It is fully expected that this comparison will hold true for the rest of the 10-year permit period, which expires in 1934. Stockmen have had the advantage of a low fee during years of favorable market conditions and the advantage also of an assurance that during the life of the 10-year permits the charge would be uniform. Presumably, favorable conditions will be restored in the industry in no very long time. It is believed that the present policy is not unfair, but will lend greater stability to the business generally and to the business of those benefiting from national-forest range administration and use in particular.

Table 13 shows the grazing use made of the national forests in the calendar year 1930.

TABLE 13.—*Grazing permits issued and numbers of stock grazed under pay permit on the national forests, by States, calendar year 1930*

State	Cattle, horses, and swine			Sheep and goats	
	Permits issued	Stock grazed		Permits issued	Stock grazed
		Cattle and horses	Swine		
Alabama.....	2	10	.....	.....	.....
Arizona.....	1,096	172,315	272	123	324,222
Arkansas.....	28	394	.....	.....	.....
California.....	1,882	148,300	179	366	409,018
Colorado.....	2,807	272,209	.....	923	1,035,225
Florida.....	6	443	.....	3	1,483
Idaho.....	2,644	119,981	.....	1,027	1,295,970
Montana.....	2,132	131,554	.....	472	609,995
Nebraska.....	31	11,315	.....	.....	.....
Nevada.....	373	51,023	.....	143	318,318
New Hampshire.....	19	136	.....	.....	.....
New Mexico.....	1,936	82,633	84	283	239,107
North Carolina.....	38	263	.....	3	34
Oklahoma.....	46	2,439	.....	.....	.....
Oregon.....	1,086	85,489	.....	514	667,708
South Dakota.....	698	27,510	.....	44	32,617
Tennessee.....	22	290	.....	2	70
Utah.....	3,891	110,261	5	2,062	776,656
Virginia.....	70	701	.....	15	428
Washington.....	397	13,493	.....	163	179,044
West Virginia.....	27	210	.....	36	943
Wyoming.....	738	107,734	.....	305	655,622
Total, 1930.....	19,969	1,338,703	540	6,484	6,546,460
Total, 1929.....	19,873	1,370,636	853	6,574	6,666,206

In consequence of a change in form of the statistical records of grazing, Table 13 combines cattle with horses and does not separate the sheep from the goats. During 1930 there were 31,933 fewer cattle and horses and 119,746 fewer sheep and goats grazing under

pay permit than in the previous year. Had all the stock authorized under pay permit (1,356,656 cattle and horses and 6,773,476 sheep and goats) been actually grazed, the forests would have supported the equivalent of 7,474 cattle more than were grazed in 1929. The difference between the number under permit and the number actually grazed is almost entirely governed by business conditions.

Numbers of stock alone are misleading. In terms of cow-months of actual use, for example, the forests carried under pay permit in 1930 the equivalent of more than 100,000 cow-months in excess of the number in 1929. Cattle used the ranges twenty-five one-hundredths of a month longer and sheep eight one-hundredths of a month longer.

The number of term permits issued and the numbers of stock grazed under them remained about the same as in 1929.

Under the policy explained in the report for 1929 with respect to nonuse, range was held for more than 89,000 cattle and horses and more than 239,000 sheep and goats.

RANGE IMPROVEMENTS

The construction of range improvements under a definite program is having a beneficial effect on the range and related resources. Some of the more difficult situations have been remedied, and others are on the way to satisfactory correction, in consequence of the availability of funds to build projects necessary to adequate control of the livestock. Furthermore, the Government is redeeming its responsibility as a good landlord. During 1930, with the Federal funds made available and cooperative contributions, improvements were completed as indicated in Table 14.

TABLE 14.—*Range improvements constructed on national forests, calendar year 1930*

Region	Fences		Corrals		Driveways		Stock bridges		Water develop-ments		Total cost
	Miles	Cost	Num-ber	Cost	Miles	Cost	Num-ber	Cost	Num-ber	Cost	
1.....	48	\$16,254	2	\$259	13	\$1,169	1	\$ 436	103	\$8,206	\$26,324
2.....	68	16,063	2	500	51	2,600	7	4,742	93	6,275	30,180
3.....	475	106,036	12	626					26	34,760	141,422
4.....	58	20,885	2	719	28	992	4	672	261	40,488	63,756
5.....	34	9,830	1	160	9	717			63	10,780	21,487
6.....	56	9,910	6	343	94	1,059	1	520	155	10,057	21,889
Total.....	739	178,978	25	2,607	195	6,537	13	6,370	701	110,566	365,058

GRAZING TRESPASS AND LIVESTOCK LOSSES

Some progress was made in eliminating wild and worthless horses from the range. It was accomplished through the application of orders issued by the Secretary of Agriculture, closing certain areas for definite periods and authorizing forest officers to dispose of animals found on these areas during the closed periods. The application of the impounding regulation also is proving beneficial. The validity of both of these measures has been upheld by the courts.

More accurate data were secured on livestock losses than in former years. It is believed that this was the main reason for an apparent increase in the 1930 losses shown in Table 15 over the losses in 1929. The totals seems large, but in comparison with the number of stock on the forests they are small—a little more than 1 per cent for cattle, and a little more than 2 per cent for sheep. Considering the period grazed, the losses are no greater than those on private ranges and are much less than those on the open public domain. The data, however, point to a leak in the industry which should be greatly reduced. Continued efforts on the part of both stockmen and forest officers to develop and install plans for a more successful control of these losses is called for.

TABLE 15.—*Livestock losses, calendar year 1930*

CATTLE AND HORSES

Region	Stock lost—									
	From poisonous plants		From predatory animals		Through disease		Through other causes		Total	
	Num-ber	Value	Num-ber	Value	Num-ber	Value	Num-ber	Value	Num-ber	Value
1.....	200	\$13,335	24	\$1,600	174	\$11,600	446	\$29,735	844	\$56,270
2.....	2,269	151,275	71	4,735	1,023	68,205	1,308	87,205	4,671	311,420
3.....	657	43,800	892	59,470	630	42,000	1,929	128,605	4,108	273,875
4.....	1,590	106,000	211	14,065	352	23,460	1,294	86,270	3,447	229,795
5.....	537	35,800	32	2,135	238	15,865	1,265	84,335	2,072	138,135
6.....	161	10,730	27	1,800	157	10,465	551	36,735	896	59,730
Total...	5,414	360,940	1,257	83,805	2,574	171,595	6,793	452,885	16,033	1,069,225

SHEEP AND GOATS

1.....	2,611	\$26,110	6,812	\$63,120	1,108	\$11,080	7,777	\$77,770	18,308	\$183,080
2.....	5,301	53,010	8,728	87,280	2,956	29,560	10,244	102,440	27,229	272,290
3.....	1,154	11,540	2,618	26,180	894	8,940	555	5,550	5,221	52,210
4.....	10,789	107,890	30,765	307,650	4,383	43,830	19,147	191,470	65,084	650,840
5.....	1,954	19,540	3,053	30,530	1,654	16,540	2,526	25,260	9,187	91,870
6.....	3,074	30,740	7,693	76,930	2,946	29,460	7,499	74,990	21,212	212,120
Total...	24,833	248,830	59,669	596,690	13,941	139,410	47,748	477,480	146,241	1,462,410

STABILITY OF RANGE USE

The annual report for 1929 contained a discussion of range stability and the effects of improved range management. During 1930 some question was raised as to whether the decline in numbers of livestock was not largely due to the efforts of the Forest Service to increase the number of big-game animals, and to restrictions on livestock in the interest of recreation and better watershed and timber production. On the other hand, some game enthusiasts attempted to show that national-forest ranges were monopolized by the stockmen and that game interests were not being fully protected.

The Forest Service has endeavored to maintain a balanced program which would accord all interests full consideration. The situation is one which demands calm consideration, study, development of all the facts, and the fair and harmonious working out of the problem in cooperation with all those affected. The stockman views with considerable alarm reported increases of the past 5-year period

in big-game animals, and the critical conditions which have been and are developing on certain national forests by reason of an overpopulation of game animals. He sees a danger of gradual curtailment of his valuable privilege, although at the same time he is sympathetic to the needs of wild life and resents the implication that he is responsible for its destruction.

When the facts are fully known it becomes evident that many of the assertions in regard to the damage to game by the presence of livestock are not only exaggerated but unsubstantiated. Much of the alleged damage is due to other causes than livestock, causes often unknown to those who criticize. That game animals do not increase more rapidly in certain localities is often due to inadequate winter range outside the national forests, illegal killing, predatory animals, disease, and parasites. From a broad point of view it is believed there is no occasion for alarm. It is true that big-game animals have increased on national forests. It is equally true that restrictions have been made on the grazing of livestock in the interests of game; but no serious actual reduction in numbers of livestock has been made. Areas have been reserved for game purposes, but these reservations have been made gradually, and their loss to livestock interests has been fully compensated for by improved range conditions and management on the rest of their allotments.

Of the total net area of over 132,000,000 acres of national-forest land in the Western States over 86,000,000 acres, or about 65 per cent, is usable range. Of the usable range over 82,000,000 acres, or about 95 per cent, is actually used by domestic livestock. Game animals occupy over 45,000,000 acres of land considered unusable by domestic stock but constituting excellent game range, over 2,500,000 acres closed to use by domestic stock, and over 2,000,000 acres reserved from grazing for other uses. Thus there are nearly 50,000,000 acres of good game range on which domestic livestock does not graze. In addition much range is occupied by both game and domestic livestock, the capacity of the range being determined by the amount of feed available for each class of animals. On the 288 game refuges within the national forests domestic livestock has been restricted to the equivalent of the carrying capacity of 2,000,000 acres.

It should be understood that the necessary adjustments between livestock and game have extended over a period of 25 years. During this long period of gradual adjustment not more than one-fifth of 1 per cent per year of the usable range has been closed to use by domestic stock for game, and this has been largely offset by the opening of new range and by increases in the carrying capacity of old ranges, under regulated grazing.

There has been a reduction in stock months during the last five years of approximately 5.6 per cent. Of this reduction, 28 per cent was in numbers of stock and 57 per cent through shortening the grazing season to protect the productivity of the range. The remaining 15 per cent of the reduction resulted from forfeitures of privileges and the use of surplus range so secured for further protection purposes. It may be, of course, that in some of these cases reductions were made in the interest of both game and livestock. It is certain that the drought period is chiefly responsible and that outright reductions in the interest of game have been inconsequential.

It should be understood that game was almost exterminated on many areas when the national forests were created. The increase in numbers was most gradual, and for many years was hardly noticeable. Systematic protection and the reduction of predatory animals have created a more favorable environment, so that during recent years pronounced increases have occurred. While these increases have occurred on ranges occupied by both domestic stock and game animals, a large part of the increase is on ranges having no domestic stock and, until comparatively recent years, only a few game animals. There are still areas where a large number of game animals and birds might be produced without interference with domestic livestock.

The Forest Service would not be redeeming its responsibility if it failed to recognize the possibility of making all lands fully productive. This involves the devoting of national-forest lands to their highest use. In the application of this principle adjustments in use must be made. They will be difficult to make if the various interests are indifferent to or unfamiliar with the facts, or are unwilling to recognize that a variety of uses may be secured from the same tract of land. Experience has shown that controversies may be amicably settled by a joint examination and study of individual areas. Studies so conducted have in the past proved conclusively that views may be harmonized, reductions in livestock or in game secured, and a plan formulated which will work in the interest of all concerned. As custodian of Federal property, the Forest Service must prevent damage to the land and resources. This means that decisive action must be taken in cases where the land is being occupied by a number of animals, either domestic livestock or game, or both, in excess of the permanent carrying capacity of the range.

RECREATION AND GAME

The inspirational and recreational values of the national forests grow in popularity with each passing year, particularly as new regions are made accessible by Federal and State highway construction. Since 1916 the number of visitors has increased more than tenfold. Access to the national forests is unrestricted except during brief periods of critical fire danger, and the number of visitors can only be estimated, on the basis of available data and personal observation. While such estimates are necessarily approximations, they correctly reflect the year-to-year changes in this form of use. For the calendar year 1930 the estimated number of visitors was 31,904,452, a slight increase from the preceding year. It included 326,826 special-use permittees and guests, 1,330,610 hotel and resort guests, 1,980,736 campers, 3,272,680 picnickers, and 24,993,600 transient motorists.

Much of this use is by local residents, but a substantial part is by people from remote sections. Motor cars from every State and Territory in the Union are to be found on the national-forest roads and camp grounds. The resulting business is of great importance to local commercial enterprises, so that the recreational potentialities of the national forests now have a substantial significance for their regions.

Without reasonably adequate provision for the maintenance of sanitary conditions and the prevention of fires this enormous influx of people would create serious hazards to public health and property. The establishment of public camp grounds minimizes these hazards. The provision of 156 additional improved camp grounds during the year increased the total to 1,731, but many of them are only partially equipped with the facilities required to bring them up to proper standards of safety and convenience. The total cost of this system of national-forest public camp grounds to December 31, 1930, was \$383,740, of which \$52,601 was contributed by public and private cooperators in cash, materials, and labor.

The greater proportion of visitors use and observe only those national-forest lands which adjoin the highways. In order that the scenic beauties so important to them may be unimpaired, the Forest Service has established the rule that no use of national-forest lands or resources within 200 feet of a class A or class B forest or State highway, or within 100 feet of a class C road, shall be allowed except in conformity with carefully prepared plans or as especially authorized by the regional foresters. This rule meets with general approval and will receive general application.

Table 16 shows more than a million big-game animals on the national forests—a gain of approximately 9 per cent over the number in 1929. The numbers are obtained by estimates of experienced forest officers, and are, therefore, approximations, but they are believed to be as nearly accurate as the nature of the case permits.

TABLE 16.—*Number of big-game animals and beaver on national forests, by States, estimated as of December 31, 1930*

State	Antelope	Bear		Deer	Elk	Moose	Mountain goats	Mountain sheep	Beaver
		Black or brown	Grizzly						
Alabama.....				500					
Alaska.....		5,750	12,800	63,500	14	580	10,300	1,000	425
Arizona.....	4,680	623	9	91,350	2,715			275	5,200
Arkansas.....		2		1,945					
California.....	1,200	8,984		259,298	87			600	70
Colorado.....	102	2,684	17	36,380	10,472			3,450	39,236
Florida.....		122		2,650					
Idaho.....	2,223	5,448	110	64,100	9,305	669	3,350	1,600	13,740
Michigan.....		50		175					6
Minnesota.....		1,455		8,500		2,276			6,020
Montana.....	500	5,496	526	53,560	13,006	1,568	4,196	2,170	16,239
Nebraska.....				96					
Nevada.....	196			7,034				145	162
New Hampshire.....		800		3,000		4			20
New Mexico.....	1,035	925	18	81,250	350			175	1,335
North Carolina.....		181		5,616	38				
Oklahoma.....	1	4		375	350				
Oregon.....	185	6,272		84,520	8,956			60	3,275
Pennsylvania.....		300		5,000	4				100
South Dakota.....	500			5,224	341		3		820
Tennessee.....		18		235					
Utah.....		234	1	54,749	3,105			169	2,866
Virginia.....		550		81	75				
Washington.....		8,336	17	31,002	8,801		4,017	6	11,420
West Virginia.....		300		30					
Wyoming.....	520	1,645	172	17,610	30,595	2,667		2,846	8,323
Total.....	11,142	50,179	3,670	877,780	88,214	7,764	21,866	12,496	109,257

¹ Includes Alaska brown bear.

Leaders in conservation have long recognized that wild life in this country is fast diminishing. The subject has been widely discussed during the past year, and a comprehensive national wild-life policy has been placed before the public by the American Game Protective Association. The situation led to the appointment of a Senate Committee on Wild Life which conducted an inquiry and held extended hearings. Its report to the Senate clearly and forcefully presented the situation. It is believed that the wild-life situation on the national forests is far better than that generally prevailing. Nevertheless, much remains to be done. It is the desire of the Forest Service that the national forests take their proper place in any national program which may be developed.

In order that the Forest Service might have the benefit of the views of competent authorities, a committee composed of representatives of interested organizations was invited to review the work of the Forest Service and the conditions prevailing on the Kaibab National Forest. The committee made the investigation during the period from June 8 to 15, 1931, and submitted a report which will aid greatly in future administration.

WATER POWER

Of the water-power permits and easements issued by the Department of Agriculture, 240 were in force at the close of the year, of which 161 required an annual rental and 79 were free. Of the free permits and easements 57 were for power projects, having an estimated output of 25,897 horsepower, and 22 were for transmission lines, with a length within the forest boundaries of 155.4 miles. The rental permits or easements comprised 55 for power projects, with an estimated output of 514,610 horsepower, and 106 for transmission lines, with a length within the forest boundaries of 887.77 miles.

The new Federal Power Commission authorized the continuance of the past practice under which its field work has been performed through the field organizations of the Departments of Agriculture, War, and Interior. During the year the Forest Service handled a large amount of such work in the form of field engineering and supervision over projects. At the request of the commission the Forest Service also engaged in valuation and accounting work on a number of important projects.

At the close of the fiscal year the regional foresters were supervising the operations of 401 permittees or licenses, an increase of 69. During the year the commission requested field investigations and reports in 46 cases of application for permit or license. The Forest Service reported on 46 cases and also made valuations and appraisals upon 6 cases. Of the 64 projects for which applications were received by the commission during the year, 43 involved the use of national-forest land. The regional foresters issued 11 permits for projects of 40 horsepower and less, for periods not exceeding 10 years.

In a number of cases difficulties have arisen through conflicting uses. To decide which is the more important, a determination must be made of all the values involved. Interferences of dam and reservoir projects with road projects have brought conflicts between the use of land for irrigation and power development and for highway building in the Snake River Canyon and on the Kings River, and

between use for power and use for a road on the Salmon and North Umpqua Rivers and on the South Fork of the Payette River. The forests must have plans which will provide for the utilization of the land for its highest value, and which will also provide where possible for a correlated utilization of other values. A valuation for power is a difficult matter, but steps have been taken which it is believed will lead to a satisfactory outcome.

Some confusion has arisen through power classifications and withdrawals within the national forests made by the Geological Survey without the knowledge of the Forest Service. Arrangements have now been made whereby the Geological Survey will permit a more accurate determination by the Forest Service of what forest lands should be withdrawn or classified. Past withdrawals and classifications will be reviewed and field investigations made wherever deemed necessary. Requests by the Forest Service for additional withdrawals and classifications may follow as a result of completed forest-utilization plans.

In April the commission rescinded the order under which the regional foresters have had authority since 1923 to issue licenses for periods not greater than 10 years, for power projects located entirely within the national forests and of not exceeding 40-horse-power capacity.

ROADS AND TRAILS

Table 17 shows the mileage and the estimated expenditure required to complete the planned system of transportation for the national forests. It includes forest highways, forest-development roads, and trails. Forest highways are of primary importance to States, counties, and local communities; development roads are of primary value for the protection, administration, development, and use of the forests; and trails are of primary use for protection. More intensive study of the transportation needs of the properties has added a considerable mileage of new development roads and trails not included in the system as reported last year.

TABLE 17.—*Classification of mileage in forest road and trail system, and expenditures required to complete the system to a satisfactory standard*

Class	Total	Satisfactory standard	Unsatisfactory standard	Non-existing	Expenditures required to complete
	<i>Miles</i>	<i>Miles</i>	<i>Miles</i>	<i>Miles</i>	<i>Dollars</i>
Forest highways.....	16, 532	6, 122	9, 048	1, 362	189, 100, 890
Forest-development roads.....	65, 861	22, 724	16, 638	26, 499	65, 056, 590
Trails.....	155, 597	112, 427	9, 047	34, 123	5, 497, 990
Total.....	237, 990	141, 273	34, 733	61, 984	259, 655, 470

Tables 18 to 20, inclusive, furnish information regarding forest-road appropriations and accomplishments. A large number of what are known as "motorways" and "trailways," providing more simple and inexpensive means of travel than the regular development roads and the regulation trails, were constructed in place of or supplementing the latter. The total mileage of all construction is shown in Table 18.

TABLE 18.—*Construction, improvement, and maintenance of roads and trails from forest road appropriations and other Federal and cooperative funds, by States, June 30, 1931*

State	Fiscal year 1931				Total to June 30, 1931		Expenditure to June 30, 1931		
	Constructed		Maintained		Constructed		Federal funds	Cooperative funds	Total funds
	Roads	Trails	Roads	Trails	Roads	Trails			
	Miles	Miles	Miles	Miles	Miles	Miles			
Ala.	12.6		114.9		63.1		\$138,797.11	\$25,278.16	\$164,075.27
Alaska	10.0	41.2	230.2	162.0	237.1	439.7	5,362,909.17	352,747.35	5,715,656.52
Ariz.	327.6	110.5	1,952.7	2,860.0	1,808.6	1,748.5	6,789,010.99	965,223.10	7,754,234.09
Ark.	171.9	127.5	257.2	518.6	648.4	646.4	1,512,150.31	30,313.14	1,542,463.45
Calif.	762.4	401.2	9,610.5	18,007.7	3,297.7	3,947.8	16,271,263.49	4,954,451.45	21,225,714.94
Colo.	79.3	422.4	772.4	11,420.8	1,480.9	5,067.3	7,502,648.56	933,740.41	8,436,388.97
Fla.	575.8		65.0		824.7		497,652.27	138,661.18	636,313.45
Ga.	48.3	40.0	197.2		112.3	252.6	582,054.33	74,943.61	656,997.94
Idaho	310.9	2,216.4	2,660.6	19,581.0	2,352.9	14,383.5	15,868,975.78	1,828,846.45	17,697,822.23
Ill.							427.24		427.24
Kans.					3.4		2,111.51		2,111.51
Ky.							808.72		808.72
La.	77.5				77.5		19,765.00		19,765.00
Me.		15.2	5.3	45.8	5.3	61.0	49,332.48		49,332.48
Md.							70.05		70.05
Mich.	176.5		244.0		260.5		184,718.09	394.93	185,113.02
Minn.	27.3	40.0	284.8	369.6	390.3	536.7	880,438.43	268,277.07	1,148,715.50
Mont.	146.4	2,333.8	1,575.3	14,935.2	1,139.2	9,157.0	9,441,382.09	645,885.59	10,087,267.68
Nebr.			48.8		48.3		103,524.51	990.80	104,515.31
Nev.	25.8	42.5	320.5	1,514.0	479.9	896.1	1,595,026.08	155,717.16	1,750,743.24
N. H.	9.7	39.0	43.0	446.0	57.9	485.0	393,234.46	18,474.83	411,709.29
N. J.							217.71		217.71
N. Mex.	189.2	66.0	1,595.0	3,109.0	1,040.5	1,558.1	4,703,041.77	328,394.05	5,031,435.82
N. Y.							81.32		81.32
N. C.	30.5	27.6	213.2	595.3	200.7	640.6	861,829.06	503,726.57	1,365,555.63
N. Dak.					1.0		57.75		57.75
Okla.	3.0		19.1		27.7	16.5	78,822.03	12,362.16	91,184.19
Oreg.	633.8	895.5	6,176.7	14,161.8	3,659.4	7,388.0	14,724,890.23	6,739,232.86	21,464,123.09
Pa.	12.0	23.0	124.5		59.2		173,316.16	21,850.54	195,166.70
Porto Rico.	2.0			36.3	6.6		22,521.15	550.00	23,071.15
S. C.			12.0	10.0	6.3	18.2	111,011.41	15,659.81	126,671.22
S. Dak.	20.5	5.9	138.0	41.6	307.8	77.6	952,278.58	243,496.11	1,195,774.69
Tenn.	12.2	45.5	83.8	577.9	105.3	620.4	516,248.88	189,884.30	706,133.18
Utah	118.9	169.3	1,063.9	3,095.8	1,185.2	3,617.6	3,943,047.06	905,558.47	4,848,605.53
Va.	24.6	78.6	74.1	443.2	135.5	871.8	726,719.46	50,856.11	777,575.57
Wash.	274.0	1,198.4	2,006.3	11,871.0	1,287.1	6,628.5	9,500,518.24	1,644,715.61	11,145,233.85
W. Va.	39.0	100.0	118.8	339.9	117.0	443.7	347,953.56	5,300.00	353,253.56
Wis.	65.4				65.4		63,133.43	1,820.00	64,953.43
Wyo.	51.2	172.2	757.2	4,860.0	1,025.6	2,375.0	4,801,142.27	388,756.52	5,189,898.79
Total.	4,238.3	8,611.7	30,725.8	109,199.7	22,518.3	61,936.9	108,723,130.74	21,446,108.34	130,169,239.08

TABLE 19.—*Distribution among the States of the apportionments for the fiscal year 1932*

State	10 per cent fund	Forest high-ways	Forest-road development	Total
Alabama	\$54.55	\$7,990.00	\$13,484.00	\$21,528.55
Alaska	5,172.55	945,548.00	18,123.00	968,843.55
Arizona	27,567.83	593,906.00	155,482.00	776,955.83
Arkansas	8,014.28	92,244.00	75,689.00	175,947.28
California	112,329.78	1,432,765.00	517,317.00	2,062,411.78
Colorado	54,084.80	678,687.00	195,213.00	927,984.80
Florida	4,023.90	32,769.00	18,143.00	54,935.90
Georgia	868.09	19,385.00	27,827.00	48,080.09
Idaho	53,232.45	1,045,437.00	483,866.00	1,582,535.45
Illinois		826.00		826.00
Louisiana	.65	764.00	5,268.00	6,032.65
Maine	321.44	2,889.00	2,223.00	5,433.44
Michigan	393.06	17,680.00	30,994.00	49,067.06
Minnesota	3,553.45	64,333.00	21,320.00	89,206.45
Montana	26,860.79	819,893.00	281,255.00	1,128,008.79
Nebraska	842.45	9,821.00	1,624.00	12,287.45
Nevada	10,372.28	187,008.00	17,764.00	215,144.28

TABLE 19.—*Distribution among the States of the apportionments for the fiscal year 1932—Continued*

State	10 per cent fund	Forest high-ways	Forest-road development	Total
New Hampshire	4,631.38	45,608.00	18,459.00	68,698.38
New Mexico	12,884.58	415,539.00	101,940.00	530,363.58
North Carolina	1,901.57	28,060.00	35,609.00	65,570.57
Oklahoma	605.91	3,628.00	8,365.00	12,598.91
Oregon	49,023.00	1,344,741.00	405,314.00	1,799,078.00
Pennsylvania	1,333.75	18,553.00	30,448.00	50,334.75
Porto Rico	25.50	1,127.00	2,071.00	3,223.50
South Carolina	254.39	3,376.00	1,834.00	5,464.39
South Dakota	12,839.69	79,984.00	17,591.00	110,414.69
Tennessee	1,206.14	25,724.00	22,447.00	49,377.14
Utah	23,221.89	338,185.00	66,039.00	427,445.89
Virginia	2,341.50	32,371.00	34,663.00	69,375.50
Washington	46,069.60	739,295.00	241,761.00	1,027,125.60
West Virginia	189.53	15,739.00	28,222.00	44,150.53
Wisconsin	.63	6,281.00	15,546.00	21,827.63
Wyoming	32,022.18	449,844.00	104,099.00	585,965.18
Undistributed			¹ 1,229,200.00	1,229,200.00
Total	496,243.59	9,500,000.00	4,229,200.00	14,225,443.59

¹ Improvement appropriation.TABLE 20.—*Distribution among States of the total apportionments, including the fiscal year 1932*

States	10 per cent fund	Section 8	Federal forest road construction	Forest high-ways	Forest road development	Improvement	Grand total
Ala.	\$938.77	\$15,456.04	\$1,922.31	\$46,159.00	\$81,597.00	\$16,800.00	\$162,873.12
Alaska	166,607.33	471,111.29	193,549.95	5,945,184.00	236,634.00		7,013,086.57
Ariz.	633,757.26	680,711.90	501,984.55	3,839,308.00	1,504,814.00	295,613.93	7,456,189.64
Ark.	130,319.74	175,008.19	128,773.38	517,079.00	564,121.00	220,639.38	1,735,940.69
Calif.	1,629,161.45	1,468,307.11	1,206,815.23	9,281,860.00	4,559,524.00	614,890.45	18,760,558.24
Colo.	753,404.83	760,499.26	777,307.26	4,520,550.00	1,758,494.00	46,932.53	8,617,187.88
Fla.	42,509.72	119,528.14	21,534.94	172,119.00	1,533,735.00	92,218.38	601,645.18
Ga.	12,217.61	52,393.57	134,387.16	114,489.00	199,136.00	110,753.71	623,377.05
Idaho	964,662.38	1,199,108.38	1,367,402.82	6,869,191.00	6,572,284.00	912,371.06	17,885,019.64
Ill.				3,493.00	366.00		3,859.00
Kans.	1,867.27						1,867.27
Ky.	722.72				86.00		808.72
La.	.65			1,029.00	5,268.00	19,500.00	25,797.65
Me.	3,820.13	32.41	3,738.77	18,004.00	26,357.00	1,788.46	53,740.77
Md.	70.05						70.05
Mich.	3,821.83	115.63	3,000.00	60,281.00	95,293.00	94,037.66	256,549.12
Minn.	42,852.12	8,292.73	108,352.03	404,874.00	362,218.00	76,084.39	1,002,673.27
Mont.	598,336.41	756,605.60	731,497.39	5,465,160.00	3,332,903.00	234,355.01	11,118,857.41
Nebr.	19,406.39	18.98		65,918.00	30,371.00	578.27	116,292.64
Nev.	178,252.54	195,210.76	82,265.33	1,291,845.00	150,188.00	19,002.61	1,916,764.24
N. H.	50,851.69	341.66	10,641.30	254,639.00	156,022.00	20,611.54	493,407.49
N. J.	118.99				83.00		201.99
N. M.	352,144.63	430,754.76	509,215.36	2,821,469.00	1,162,920.00	227,686.07	5,504,189.82
N. Y.	4.00				20.00		24.00
N. C.	37,715.34	84,733.83	176,890.28	180,439.00	321,537.00	123,322.28	924,637.73
N. D.	45.75	7.00					52.75
Okl.	10,422.38	65.49	2,775.17	29,428.00	33,588.00	14,257.56	90,536.60
Oreg.	1,035,027.95	1,432,791.37	1,077,552.29	8,205,657.00	4,761,057.00	466,194.69	16,978,280.30
Pa.	4,727.50	24.04	21.42	72,018.00	121,214.00	38,000.00	236,004.96
P. R.	120.10	7.00	3,343.09	8,051.00	15,199.00	1,904.35	28,624.54
S. C.	3,080.94	402.10	48,028.61	19,967.00	47,433.00		118,911.65
S. D.	184,209.61	83,820.89	79,341.53	508,705.00	214,958.00	24,548.87	1,095,583.90
Tenn.	19,770.25	103,433.37	28,092.79	150,049.00	221,446.00	35,421.69	558,213.10
Utah	407,394.34	446,148.17	464,562.35	2,303,544.00	691,513.00	88,523.42	4,401,685.28
Va.	46,081.40	58,390.16	71,902.26	202,595.00	313,056.00	93,508.90	785,533.72
Wash.	660,506.50	940,156.07	712,201.40	4,568,625.00	3,451,376.00	430,451.57	10,763,316.54
W. Va.	5,986.32	12,830.41	5,049.24	76,935.00	178,087.31	123,931.31	402,819.28
Wis.	.63			8,530.00	15,546.00	58,851.41	82,928.04
Wyo.	449,340.58	472,384.91	547,551.79	2,972,806.00	1,161,526.00	46,842.71	5,650,451.99
Undistributed		31,308.78				1,229,200.00	1,260,508.78
Total	8,450,278.40	10,000,000.00	9,000,000.00	61,000,000.00	32,500,000.00	5,778,822.21	126,729,100.61

¹ Includes \$3,000,000 appropriated for first emergency-highways within national forest.² Does not include unexpended balance in annual funds: \$2,993.98 of \$1,500,000 improvement appropriation; \$383.81 of \$3,053,000 first emergency improvement appropriation.

TABLE 21.—*Condition of forest-road funds on June 30, 1931*

Fund	Appropriations	Expenditures	Balance
10 per cent.....	\$7,954,034.81	\$7,559,239.76	\$394,795.05
Section 8.....	10,000,000.00	9,968,691.22	31,308.78
Federal forest-road construction.....	9,000,000.00	9,000,000.00	-----
Forest highways.....	48,555,000.00	45,786,060.57	2,768,939.43
Forest road development.....	29,500,000.00	29,295,282.09	204,717.91
Improvement.....	4,553,000.00	4,549,622.21	3,377.79
Total.....	109,562,034.81	106,158,895.85	3,403,138.96

Under the regular procedure \$12,500,000 was authorized for the fiscal year 1931 for the construction of forest roads and trails. Of this amount \$9,500,000 was provided for forest highways and the remaining \$3,000,000 for development roads and trails. Under the legislation to increase employment, enacted December 20, 1930, an additional \$3,000,000 was appropriated for the construction of forest highways, and the same amount for the construction of development roads and trails. While the \$9,500,000 originally authorized for forest highways could be expended upon any road included in the forest-highway system, the expenditure of the \$3,000,000 forest-highways emergency appropriation was restricted by the law to sections located within the forest boundaries.

Both of the \$3,000,000 appropriations were to be expended or placed under contract before July 1, 1931, under the terms of the act. The forest-development road money was allotted to many small projects, with results that have already been recounted. In spite of the fact that the construction went on in the winter season and consequently under bad-weather conditions, very satisfactory results were obtained.

The forest-highway appropriation under the act of December 20, 1930, is being expended upon major road projects by the Bureau of Public Roads. Since practically all such projects are handled by contract it is necessary in each case to make a location survey and to prepare plans and estimates. Naturally this prevented starting the construction immediately. However, the total amount was under contract by July 1 and will be expended during the present field season.

Because of difficulties encountered in purchasing road equipment and the fact that an unusually large amount of such equipment would have to be obtained before the beginning of the field season, the men in charge of the road work in the several regions were called to Washington in December for a general conference. After discussing the value and use of the various kinds of equipment, decisions were reached on the specifications to be used and the amount of equipment to be ordered. Purchases of road machinery for all the regions were consolidated and handled by the Washington office. This effected a considerable saving.

The meeting also brought about a correlation of construction ideas and methods and better use of machinery during the various steps of construction. Marked advances have been made in the construction methods for minor roads, particularly in the use of machinery for practically all of the work. The machinery used is larger and more powerful than formerly and is better adapted to the special conditions encountered. Equipment intended for other purposes has

been redesigned and remodeled so as to adapt it to use in the character of construction involved for protection roads. All of this has greatly reduced the cost of minor-road construction. Present costs are from 50 to 75 per cent of what they were five years ago.

Last year's annual report recounted at some length the objectives that govern the planning of national-forest transportation systems and described the methods pursued in building up the plans for individual forests. The planning work is being pushed upon a number of the forests in each region, with particular stress upon those where the fire danger is greatest. A number of important questions have arisen which must be decided before the plans can be completely formulated. These questions are being given further careful study, and decisions will be made regarding them during the present year.

MAPS AND SURVEYS

During the year the Forest Service published for administrative use 24 maps of individual national forests on a scale of one-fourth inch to the mile, 14 on a scale of one-half inch to the mile, and 4 on a scale of 1 inch to the mile. An index map of the United States showing the location of the national forests was published, 7 proclamation diagrams were issued in cooperation with the State Department, and more than 50 maps, charts, graphs, and illustrations for reports were lithographed.

The major work of the Washington section of drafting consisted of compiling and tracing 12 forest maps, compiling, tracing, or revising 14 miscellaneous maps, amending 49 maps, tracing overlays for 15 recreation maps, preparing 217 maps for congressional, court, and public committee hearings and other purposes, coloring 95 type maps, charts, and transparencies, preparing 492 graphs, forms, and mechanical and botanical drawings, and executing 1,488 charts, posters, and other miscellaneous drafting projects.

Topographic surveys were made on the Kootenai, Flathead, Clearwater, Shasta, Olympic, Ochoco, Malheur, Whitman, and Umatilla Forests, and drainage surveys were made of large areas within the Powell, Sawtooth, and Weiser Forests. Approximately 600 miles of boundaries were established within the purchase units in the Eastern States.

Two contracts were awarded to airplane companies to obtain mapping data required for the preparation of Forest Service maps. This method of obtaining survey data should prove economical for large-scale maps.

The General Land Office surveyed or resurveyed during the year approximately 1,500,000 acres within the national forests. Of original surveys, 48 were initiated, 71 were worked upon, and 43 were completed. Of resurveys, 19 were initiated, work was done upon 35, and 21 were completed.

Three thousand eight hundred square miles of national-forest land were surveyed by the Geological Survey.

The Washington section of photography made 4,182 lantern slides, 102,550 square feet of Van Dyke prints, photostats, blue and blue-line prints, and solar bromides, 3,529 square feet of wet plate, 2,736 square feet of photographic enlargements, and 72 square feet of transparencies. It developed 7,724 films, printed 87,761 "photoviews," and mounted 21,390 square feet of maps and 3,360 prints.

RESEARCH

The necessity for a coordinated attack upon the country's forest problems was pointed out in the report of two years ago; and last year's report gave some examples of how the development of a system of regional forest and range experiment stations is making it possible to bring together and correlate research in forest and range management, forest products, forest economics, and erosion. During the year the Southwestern Forest and Range Experiment Station, covering Arizona and New Mexico, was formally organized on a regional basis, with headquarters at Tucson, in cooperation with the University of Arizona. This station brings together on an expanded basis the range investigations at the Jornada and Santa Rita Range Reserves, now experimental ranges; the range-management and erosion-stream flow studies on the national forests of the Southwest; and the forest-management studies of the former southwestern forest experiment station. Plans were also consummated, and became effective August 1, 1931, for the reorganization under the Northern Rocky Mountain station of all phases of forest research work in the region, including that in forest management which was already being conducted by the station, the forest-products work previously conducted from the regional administrative office, and the forest-survey and range investigations inaugurated by initial appropriations.

In the Pacific Northwest the office of forest products was transferred from the regional administrative office to the experiment station, and the work of the station in forest economics, including the forest survey, was materially expanded. Range investigations were commenced by the California station. At the Southern station both the survey and the forest-management studies were commenced in the bottom-land hardwoods, thus initiating in a coordinated way research in this important but little-understood forest type.

Eleven regional stations are now formally recognized by congressional appropriation. This nearly completes the skeleton of regional stations, so far as the continental United States is concerned. Stations will also be required in Alaska and the tropical possessions. The work of all the stations will have to be expanded if the urgent regional forest problems are to be taken care of.

One of the greatest needs is better knowledge of the relationships of forest and range cover with erosion and stream flow. These relationships present a vast field of complexities as to which precise knowledge is deplorably inadequate. A comprehensive program of research to determine the effect of various forms of vegetative cover on erosion and stream flow was drawn up. Its major aim is to determine to what extent and under what conditions forest, brush, and range cover affect or control water flow and erosion on large areas, and the relationships between them and soil fertility and moisture, usable water, floods, and silting. The results should furnish a guide to action in various fields by Federal, State, and other agencies. The program will be carried on, when it can be undertaken in more than a minor way, under the regional stations, and in many cases in cooperation with other bureaus and agencies.

The value of the forest experiment stations as regional forest-research centers is increased by the assignment to the stations of members from cooperating bureaus under the provisions of the McSweeney-McNary Forest Research Act. Investigations are carried on in the field of forest entomology by the Bureau of Entomology, in forest pathology by the Bureau of Plant Industry, and in wild-life management by the Bureau of Biological Survey. These investigations are fitted into the regional forest-research programs in such a way as to facilitate an effective, coordinated attack upon outstanding problems. Forest entomologists are now established at the Appalachian, Central States, Northeastern, California, and Pacific Northwest stations; forest pathologists at the Allegheny, Appalachian, Northeastern, and Southern stations; and biologists at the Appalachian, Intermountain, Lake States, Northeastern, and Southwestern stations. The Bureau of Plant Industry maintains a pathological division at the Forest Products Laboratory.

Cooperation with other Federal agencies, with State foresters and departments, and with State agricultural colleges and experiment stations is increasing. A number of reports on joint projects have been published by State agencies. Various local public and private agencies have assisted through the assignment of men to research under Forest Service direction or through furnishing equipment.

An additional experimental forest was added to the eight previously established. This, the Olustee, is part of the Osceola National Forest in northeastern Florida. The major effort on this forest, a branch of the Southern Forest Experiment Station, will be the development of naval-stores research. Most of the forest is longleaf pine, with some slash pine, cypress, and hardwoods. This area affords an unusual opportunity for much-needed investigations relating to the southern pine forest.

Funds made available for research activities under various appropriation items for the fiscal year 1931 are compared with the amounts for 1930 and 1932 in Table 22.

TABLE 22.—*Appropriations for research for 1931 as compared with those for 1930 and 1932*

Class of research	1930, directly appropriated	1931, directly appropriated	1932, directly appropriated
Forest-management investigations.....	\$413, 000	\$488, 500	\$562, 000
Forest-products investigations.....	585, 000	635, 000	641, 300
Range investigations.....	67, 000	85, 000	130, 000
Forest-economic studies.....	25, 000	50, 000	75, 000
Forest survey.....	40, 000	125, 000	200, 000
Forest-taxation study.....	65, 000	70, 000	70, 200
Forest-insurance study.....	10, 000	10, 000	10, 000
Erosion-stream flow studies.....	30, 000	30, 000	100, 000

FOREST-ECONOMIC INVESTIGATIONS

The study of practical measures for speeding up the practice of forestry on private lands and for stopping forest devastation, another major economic project authorized by the McSweeney Act, was commenced. The first phase undertaken was a study of the applicability of the principles of selective logging to the Douglas fir

type. The valuable pioneer work by the University of Washington was supplemented and strengthened by additional time and cost studies for each step in utilization, and is being carried through to final conclusions. The results will be immediately applicable to general problems of logging engineering and in selective logging practice. Preliminary indications are that the scientific application of selective logging is potentially a factor of tremendous importance to economical Douglas fir lumbering, the promotion of sustained yield, and in general the better management of this great forest resource.

Another phase of this project is the study of public-forest policies with respect to privately owned forests and public-forest ownership. An analysis was made of the present scope and tendencies of public control over private forests throughout the world. Public control in the United States has been almost wholly confined to requirements for protection against fire. Other countries, as a rule, have gone considerably farther, particularly with respect to forests that serve to prevent soil erosion or to regulate stream flow, or that serve other public interests. Most of these countries are at the same time gradually extending the area of public forests.

Additional sample counties were studied in the investigation by the Southern station of the financial aspects of private forestry practice. The forest-insurance investigation in the Pacific Northwest was directed particularly toward the determination of accurate rates. Field examinations were made of large burned areas in selected counties, and detailed statistical analyses were made of reports on some 1,500 fires to determine the influence of the variable hazard elements.

The results of a study of land utilization in Knott County, Ky., in cooperation with the Bureau of Agricultural Economics and the University of Kentucky, were analyzed and prepared for publication. These show that the steep upper slopes of the mountains are submarginal for their present agricultural use and are better adapted to timber growing. Although present utilization of timber is only about one-third of the net annual growth, the returns from the farm woodlands form about 18 per cent of the net farm income. The development of local wood-using industries and mineral resources, together with adequate roads, would make the forests a very important factor in the local economy and would facilitate forestry practice by both corporate and individual timber owners.

In the stumpage and log price investigation, reports of 3,236 privately owned stumpage and 2,493 log purchases or sales for the calendar year 1928, obtained through the cooperation of the Bureau of the Census, were compiled and published as a statistical bulletin. Reports of 4,344 stumpage and 5,055 log transactions for 1929 were also compiled and made ready for publication, and work upon the reports for 1930 was begun. Progress was made in systematizing and checking the great mass of reports for earlier years preparatory to the development of stumpage-price trends in the several forest regions, and to studies of the relation of various economic factors upon values.

Cooperation was continued with the Bureau of the Census in the collection of the lumber-production statistics for 1930 in the 12 Western States which produce over 40 per cent of the total national

cut. Editing and tabulation of data were practically completed on the biennial canvass made by the Forest Service of 1930 lumber distribution.

Combined with related data for the Canadian Provinces, secured through the cooperation of the Canadian Bureau of Statistics, these data supply the only complete picture of the movement and consumption of lumber in North America. The comprehensive statistical records of lumber production, and also those showing the production and consumption of pulpwood, wood pulp, and paper, which covered the period prior to 1926, were brought down through 1929.

An extensive revision of the data on forest areas, stands, growth, depletion, and related items, compiled in 1920 as the Capper report, was initiated. It will make available for use by the Forest Service, the Timber Conservation Board, and others, in the interim before the completion of the intensive nation-wide forest survey, the best information that can be expeditiously assembled. Although its method is essentially that of compilation, not of field surveys and primary studies, it is a major project involving a wide correlation of effort and the participation of many research and administrative units.

Through this project, the forest-taxation investigation, price studies, and all applicable projects, as well as through assignments of men for consultation and staff service, the division of forest economics is endeavoring to facilitate the work of the President's Timber Conservation Board. The work of this board and the depression in the lumber industry which gave rise to it have emphasized the fundamental part that economic forces play and must play in bringing about both public and private forest management and in the welfare of forest industries, and the critical need for pressing forward investigations in the relatively new field of forest economics.

In addition to the work of the division of forest economics, much of the research in forest management and forest products has a distinct economic bearing. All measures that tend to reduce the cost and improve the quality of the timber that is grown and to improve the market for wood products through more efficient manufacture and utilization help to make forestry practical and attractive as a business undertaking.

FOREST SURVEY

Substantial progress was made on the nation-wide forest survey, particularly on the phase comprising an inventory of the extent and quality of the remaining timber supplies and the conditions on cut-over and burned forest land. In the Douglas fir region of the Pacific Northwest, the gathering of field data on the inventory phase was brought to about 40 per cent of completion, a working plan for determining the growth and yield of the region was prepared, and the major sources of existing data on forest depletion were located and explored in a preliminary way. A study of the consumption of a large number of so-called minor forest products was begun as part of the regional wood-requirements phase. Excellent cooperation was received from the private timberland owners, individually and through their associations, and from the State foresters and several

other interested State agencies in the form of timber-cruise figures, the loan of personnel, and cash contributions.

For the southern Mississippi Basin hardwood region a detailed working plan for the resource-inventory phase was prepared and tested on a representative area. The data gathered are being analyzed to furnish a basis for a final plan of procedure. It will be necessary to cover this region by the random-sample method on an extensive scale, along the same general lines that similar surveys in Sweden, Finland, and other European countries have followed.

Cooperation was continued with the State land economic survey projects in the Lake States. To obtain timber-volume and growth data needed to apply the findings of the State projects to the forest-survey requirements, more than 600 miles of strips were run. In California cooperation with the State on a forest-cover type map resulted in very satisfactory progress. This map will be an invaluable part of the forest survey.

On the wood-requirements phase the usual statistical data on production were collected in cooperation with the Bureau of the Census, and a special study was begun on the consumption of lumber for planing-mill products and the trends in the use of wood for this purpose. Planing-mill products comprise between 35 and 40 per cent of all lumber used in manufacture, and significant changes in this form of use appear to be taking place. A comprehensive attack on the requirements phase was begun by the assignment of an experienced man to direct the work and by entering upon the preparation of a working plan.

Funds were appropriated for the inauguration of the survey in southern-pine territory and the "inland empire" (northern Idaho, western Montana, and eastern Washington). Urgent requests for the extension of the survey to other forest regions show the universally felt need for the basic economic data the project will supply. Consideration by the President's Timber Conservation Board of the economic problems of the forest industries has pointedly drawn attention to the extreme lack of reliable information on the Nation's forest situation and needs for forest products.

In brief, substantial progress was made in this highly important investigation, so fundamental for sound public and private policies relating to the use of forest lands and to the forest industries, although inability to organize the undertaking on the basis contemplated by the authorization will necessarily delay its rate of advance and time of completion.

FOREST TAXATION

The investigation of the forest-tax problem in North Carolina was completed. This study involved the collection and analysis of detailed data for the State as a whole and for three selected counties. The study of the effects of existing forest-tax legislation in the United States was continued with studies in Alabama, Indiana, Iowa, Louisiana, Maine, Massachusetts, Mississippi, Ohio, and Vermont. These investigations also included an inquiry into the organization and financing of the States and their local jurisdictions.

The survey of European tax conditions affecting forestry was nearly completed. Investigators in Europe gathered such data as

were lacking from material procurable in this country. The tax systems and forest management of Austria, England, Finland, France, Germany, Norway, Sweden, and Switzerland were studied to obtain suggestions applicable to the forest-tax problem of the United States.

Continuing the policy of making available the most important factual information currently gathered, progress reports were issued during the year on Property Taxation in Selected Towns in the Forest Land Regions of Minnesota, Tax Delinquency in the Forest Counties of the Lake States, Tax Delinquency in Selected Counties of Oregon and Washington, Assessment Ratios of Forest Property and Other Real Estate in Wisconsin, and Resources and Public Finances of Michigan in Relation to the Forest Tax Problem.

FOREST MANAGEMENT AND PROTECTION INVESTIGATIONS

Increasingly, owners and managers of forest land—Federal, State, and private—turn to the forest experiment stations for information on such matters as how to insure a prompt restocking with desirable species, what yields can be expected, and how best their forest growth can be protected from fire. As knowledge of a wide variety of forest types and conditions is extended, more definite answers are possible. New work designed to meet critical needs in several of the important forest regions was started. The current forest-management research at the Southern, California, and Appalachian Forest Experiment Stations was enlarged, and silvicultural research, with emphasis on western yellow-pine management, was inaugurated at the Inter-mountain station. The Southern station made a start on the growth and yields of the bottom-land hardwoods, and the California station on the silviculture of the redwoods. The California station more aggressively attacked the forest-fire problem by beginning a new series of studies designed to round out the work, which has already established protection principles of great value. The Southern station began a study of fire in relation to naval-stores practice, and the Appalachian station began a study of the mountain hardwood forests of north Georgia.

Studies of natural reproduction are given major emphasis at nearly every station, since the great bulk of our forest lands will be restocked by natural methods. The Pacific Northwest station has found that Douglas fir seed probably does not live more than a year after it falls, and that seed under ordinary conditions is scattered as far as 1,000 feet from the seed trees. Seedling establishment following cutting depends almost entirely upon the supply of seed and the site conditions. The station recommends, to obtain desirable reproduction, a more adequate seed supply than is ordinarily provided by scattered seed trees. With Douglas fir, in the Pacific Northwest nearly all such trees are lost, chiefly by windthrow. In the western white pine region of Idaho and Montana the loss is much less—about 15 per cent of the seed trees more than 14 inches in diameter and 20 per cent of those smaller. Seed trees in the spruce forests of the Northeast are practically certain to blow over.

As the importance of keeping stands growing thriftily has become generally recognized, owners are giving increasing attention to silvicultural-improvement practices. Experiments to determine best

methods have been under way at a number of the stations. The Southern station has been studying methods for the shortleaf pine region, testing both girdling and poisoning as a means of getting rid of trees worthless because of decay or their manner of growth. Black, red, and black-jack oak were easily killed by girdling alone, post oak and hickory less easily, and elm and black gum with decided difficulty. Poisoning kills the tops more effectively than girdling, but appears to stimulate sprouting. Girdling was determined to be cheaper than felling, but has the disadvantage of adding to the fire hazard by creating snags. In the loblolly region of Virginia, preliminary results showed that injecting poisons into the trees is cheaper than either girdling or felling. In the spruce region, the added growth obtained from released spruce and fir more than paid the cost of the treatment.

The problem of converting poor woods into good forest is common to nearly every region. In the eastern mountain region the Appalachian station found that only half the cut-over hardwood lands are restocking with trees over 3 inches in diameter, and of these 70 or 80 per cent on an average are crooked, unsound, or of the less desirable species. Much fewer than half of the saplings are unshaded and free to grow up; and of those that are free, less than half are of desirable species.

Aspen, which covers some 21,000,000 acres in the Lake States, is much less valuable than the conifers or northern hardwoods which once occupied the site. The Lake States station found that in converting aspen coppice to a more profitable forest, underplantings of white pine and white spruce give 35 to 60 per cent survival during the first three years. Norway pine apparently is unsuited for such underplanting because of its inability to withstand shade. Light measurements in the aspen thickets showed from 10 to 25 per cent light above the underbrush, with still less, of course, in the minor vegetation of ferns, grass, and weeds and on the ground. Most conifers of the region can make moderate growth when they receive 25 per cent light, but need 60 per cent for good growth. With Norway pine a definite correlation appears to exist between height growth and light intensity.

Economic conditions in the Corn Belt region of the Central States have practically forced the farmer to pasture his woodland, and to this is largely due its rather generally unproductive condition. Investigations showed that these woodland pastures are being grazed to at least five times their carrying capacity. In consequence the forest growth is retarded and deformed, and all reproduction less than 12 feet high is eliminated. This, combined with the occasional cutting of mature timber and the death of standing trees, is rapidly converting woodlands on the better agricultural soils into open pastures. In the 5-year period between 1920 and 1925 practically 3,000,000 acres of farm woodlands were eliminated. Over 90 per cent of the farm woods are being grazed more or less continuously.

Slash disposal in the western white-pine region is costly and difficult to accomplish satisfactorily because of the inflammable nature of the forest and the large amount of slash left on logged land. Yet the investigations under way in this region seem to show that slash disposal is necessary for adequate reproduction. Where slash covers more than 10 per cent of the ground fewer than 1,500 seedlings of

western white pine per acre may be expected. This is insufficient to assure a reasonably full-stocked stand at maturity. The high value of western white pine and the complexity of its management problems indicate the need for a thorough investigation of its whole life history. Seed apparently remains dormant in the litter for a year or two after maturity. Under some conditions it germinates, and under others apparently similar it does not. Although seed trees are killed by a very light fire, cones will mature on the tree and produce viable seed; yet this source of seed for restocking burned lands is uncertain and unreliable. Many of the contradictions that are at present unexplainable must be worked out before a satisfactory basis for the management of the western white-pine type can be said to exist.

Naval-stores research was actively pushed. On the small areas leased for the purpose at Starke, Fla., a number of tests were completed. Others will be finished in 1931. Relatively little further work will be done at Starke, which has been the center of the naval-stores investigations for eight years. Additional studies will be inaugurated on the new experimental forest near Lake City. A report summarizing the results of the earlier studies is being prepared.

Tests of gum production from French faces made with the new tool devised by the Southern Forest Experiment Station indicate that during the first year 22 per cent more gum is obtained from French than from American faces of the same width, and during the second year 28 per cent more. As in the case of American faces, with a standard 4-inch French face the yield from large trees is greater than from small. Insufficient data have been obtained as yet to determine the quantities obtainable from trees of different diameters.

Several fire studies were completed. A departmental bulletin on what is known as hour control, based on work done in California, was published. Hour control concerns the length of time that should be prescribed as the outside limit within which all fires on a specific area should be reached with an adequate force, and the measures necessary to make possible the attainment of the standard so set up. Another bulletin had to do with forest fires in Michigan, based on the records from 1918 to 1927, and was published by the Michigan Conservation Commission. The study disclosed that the State has in the neighborhood of 2,500 fires annually, with double that number in bad years. The number of fires is apparently increasing, but better protection has materially decreased the area burned and the size of the average fire. The study showed the need for better fire prevention in the lower half of the State and better fire suppression in the upper. Ninety-five per cent of the fires were due to carelessness, and most of the damage was done by a few large fires each year; of the fires studied 6 per cent covered 73 per cent of the total area burned over, did 68 per cent of the damage, and involved 42 per cent of the suppression costs.

A 5-year record of lightning storms and forest fires in the northern Rocky Mountain region was concluded. An analysis of nearly 15,000 reports made by the lookouts revealed recognizable differences between storm types that usually start fires and those that do not. By observing the duration of rainfall ahead of and following the

lightning, the electric activity of the storm, and the proportion of flashes that strike the earth, lookouts often can classify a storm as relatively safe or generally dangerous many hours before any resulting fires produce smoke enough for discovery. Of these lightning storms, about 34 out of 100 cause fires. Less than 10 per cent are the so-called "dry storms," in which practically no rainfall reaches the ground. Dry storms were no more dangerous than the so-called "wet storms." Observations by the lookouts of the occurrence and path of storms, the accompanying precipitation, and the percentage of lightning which strikes the ground are of direct value to the protective organization.

Another major study of weather and fuel relationships was completed by the Northeastern station, for publication by the New York State College of Forestry at Syracuse. For this region duff moisture was found to be the best criterion of fire danger and is directly correlated with evaporation. Fire does not readily start when the duff moisture is 30 per cent or greater. Whether a fire is started depends also upon the quality and structure of the duff and the character of the igniting agency; the compact duff of spruce and fir needles is less easily set afire by a match than the loose litter formed by pine needles or hardwood leaves, but the reverse is true with such compact fire as locomotive sparks and cigarettes. In hardwood leaves these easily burn through the top layers and are extinguished in the moister layer below.

Although volume tables have been prepared for many of the forest-tree species in the United States, for many others either there are no tables, or the tables are based on old methods of utilization, or are applicable only to old-growth conditions no longer commonly encountered. A considerable portion of the effort of the experiment stations has been directed toward supplying the forest owner with such tables, for calculating the contents of standing trees in the various units of measure used in the forest industries. During the year nearly 50 volume tables were prepared, largely for eastern second-growth species. Obtaining the basic measurements is a time-consuming process.

Additions were made to the series of yield tables for the important forest types and species of the country. One bulletin on Douglas fir yields was published by the department, and another on the northern white pine in the Lake States was published in cooperation with the Wisconsin Agricultural Experiment Station. The study found that white pine in Wisconsin grows at about the same rate as it does in New England. On average sites it will produce 10,500 board feet per acre at 40 years of age, and 36,500 board feet at 60 years. On the best sites yields per acre of 19,000 feet are possible in 40 years, and of 58,500 board feet in 60 years.

Yield studies for pure, even-aged natural stands have now reached a point where the preparation of normal yield tables presents little difficulty. Where mixed stands are concerned the problem is more involved, as the varying proportions of the several species present may materially affect the result. In the Sierra pine region the California station found that the presence of western yellow and sugar pines in the stand tends to increase the yield, while Douglas fir tends to decrease it. White fir and incense cedar are about average in this

respect. Probably the most complex study where mixtures of species are involved is that of the upland oaks, where as many as 15 different forest tree species may be found in a single stand. This study, which has been under way for six years, is now nearing completion.

One of the interesting problems in connection with the growth of trees and stands concerns the change that takes place in the reserve stand following cutting. Trees released from the competition of neighbors accelerate greatly in growth, and there has been considerable discussion as to whether this increased growth does not materially change the form of the tree and therefore render unusable the volume tables prepared on the basis of the old stand. Investigations in 40-year-old cuttings of western yellow pine in the Northwest revealed a general tendency for all such released trees to assume a form similar to the average form in the uncut forest. If this holds true elsewhere, the volume tables prepared for old-growth can be applied successfully to the released trees.

In cooperation with the Georgia Agricultural Experiment Station, the Appalachian Forest Experiment Station issued a preliminary report on the forests of the Georgia highlands. This showed that on the best sites yellow poplar will grow at the annual rate of over 650 board feet per acre. In the old-growth forest, subject as it has been to fire, disease, and improper cutting, a growth rate of less than 90 feet per acre was found. On old fields which have been reclaimed by forest the rate of growth is about 150 board feet an acre a year.

An outstanding contribution to forest mensuration was the publication of Correlation-Alinement Charts in Forest Research. This pointed out that purely graphic methods are inadequate for the solution of many forestry problems. The concepts of the modern science of statistics may be applied to graphs and curves with a large gain in accuracy over the familiar graphic processes. The curvilinear-correlation methods applied to forestry problems by Bruce and Reineke combine graphic and statistical technic. The former contributes flexibility, the latter accuracy. The basic assumptions are so generalized that a very wide range of problems may be solved by the methods which these two members of the research staff have developed; yet the results are rigorously checked and appraised. In consequence many problems previously considered insoluble on account of their complexity or the volume of data involved can be successfully studied.

EROSION-STREAM FLOW INVESTIGATIONS

Few lines of investigative effort bear so directly and largely upon human progress and development as those which relate to the preservation of the soil and the regularity of stream flow. Under the national program for erosion-stream flow investigations, mentioned on page 57, a small amount of work has been started in several regions, which is to be expanded during the coming year.

A departmental bulletin was published on the relation of range management to erosion and run-off, and one on soil erosion was published in cooperation with the University of Wisconsin. The latter pointed out that the soil-erosion situation in southwestern Wisconsin is due to primary soil disturbances which contribute to slight movements of the upper soil or to the concentration of water

in channels. Protection by some form of vegetation is necessary, and the best interests of all would be served if slopes of more than 25 per cent gradient were kept in timber and protected from fire and overgrazing, and if slopes of greater gradient than 15 per cent were plowed only rarely. The local situation is only part of the problem, for the eroded material and flood waters are poured into and down the Mississippi.

The Intermountain Forest and Range Experiment Station aided materially in the study of the torrential floods which devastated farms and other property last year in northern Utah. The director of the station served on the governor's special flood commission and was chairman of the committee on causes and prevention measures. This committee found that scant vegetation on portions of the watersheds was a most important contributing factor to the torrential floods, which carried off an enormous amount of fertile soil from the slopes, tore great gullies in the mountain sides, destroyed homes and other properties, and deposited boulders, rocks, mud, and other débris to a depth of as much as 10 feet on highways and farm and city property. The inability of the scant vegetation to prevent the accumulation of flood waters was particularly evident where the fairly heavy natural cover had been depleted on critical parts of the watershed by overgrazing, by fire, and to a small extent by overcutting of timber. The committee's report concludes:

There is ample evidence on the watersheds of Davis County to show that had the plant cover been approximately equal to its original natural condition, the flooding in that section from the rains of 1930 would have been far less serious, if not prevented.

These studies confirm several of the essential features of the more intensive studies on the relation of herbaceous vegetation to erosion control and summer floods in central Utah which were reported last year.

FOREST-PRODUCTS INVESTIGATIONS

For years to come the United States will probably remain first in the list of wood-using nations. Nevertheless in the last decade wood has been taking a smaller place in our total consumption of material. Meanwhile, haste and waste continue in the cutting of much of our best remaining timber. A present low consumption of forest materials tends to restrict future production.

The broader the demand for forest products the better the prospect for forestry and the stronger the incentive to engage in it. Scientific research must seek to bring about the most efficient utilization of wood in all possible forms. The Forest Products Laboratory, in promoting this and in developing and improving processes of wood conversion through studies of the physical, chemical, and biological nature of wood as a raw material, is making an increasingly important contribution to forestry.

Substantial recognition of this was recently accorded by Congress in providing for the construction of new and adequate quarters for the laboratory. With the expected completion of the structure during the summer of 1932 the laboratory will be in possession of first-rate, modern accommodations adequate for its present research program and providing for the considerable expansion of work that is sure to be needed within the next few years.

WOOD IN THE BUILDING FIELD

Lumber is the chief product of the forest, and more than 60 per cent of the lumber produced in the United States is used in residential, commercial, and other types of building construction. Wood has long been recognized as a relatively inexpensive building material. Yet during 25 years of enormous expansion in the building industry the per capita consumption of lumber has decreased by nearly one-half. It has lost much ground competitively because of lack of technical progress in wood use. Radical improvements are needed in the engineering of wood construction, so that the advantages of inexpensive material and simplified, efficient, and cheap erection may be combined to produce a truly economical structure.

One of the country's greatest problems is proper housing for the wage earner. In the average frame house or building, material and erection costs are about equally divided. Under present construction methods, mechanics earning \$12 to \$15 a day can not produce a house that is worth the money it costs. Hence, while productivity in every other industry has been materially increasing, productivity in housing has decreased. Great economy in all classes of construction would result if the utilization of short-length, narrow, low-grade lumber could be put on a sound engineering basis. The same may be said for the utilization of factory-cut stock sizes and of built-up standard members and panels, assuming that these can be manufactured in quantity and assembled rapidly into a finished structure. Improvement of wood-construction methods requires careful study of engineering design and thorough testing of structural combinations which go to make up the various elements of a house, such as framing and fastenings, beams and columns, floor systems, and outer and inner wall panels. Information bearing on fundamental problems in the field of design and erection was obtained by the Forest Products Laboratory during the year.

Test work on bolted joints was completed, and the preparation of a bulletin was begun which will present for the first time a set of comprehensive and dependable working stresses for such joints, as well as data on safe spacing and marginal allowances for bolts in wood. Tests of the lateral resistance of nails in wood proved that in holding power nails follow much the same general law as bolts, with somewhat higher efficiency.

Strengthening bolted joints by the use of special metal fastenings which act as dowels or keys offers great promise of developing maximum efficiency in wooden chord members. Six devices of this kind manufactured in Europe were tested. The best of them increased the joint strength from five to six times. Standardized metal fastenings will facilitate quantity production of timber framing and rapid erection. For a given design of structure parts can be cut to size at the factory, bored and fitted for the fastenings, and shipped either unassembled or made up into larger units. Laborious hand fitting on the site is thus replaced by quick and exact mechanical work, and added value is given to wood as an engineering material. The laboratory tests were aided by the cooperation of the National Committee on Wood Utilization.

Significant engineering data were obtained in a new study of laminated construction. Of necessity much of the lumber produced

at all mills is stock of short length, small dimension, or low quality, the sale of which is a major problem. If structural members of satisfactory strength can be built up of such material, much of the wood that now goes to waste or is disposed of at a loss can be made a source of profit. Work in this field was carried forward with the cooperation of the National Lumber Manufacturers' Association.

Most study was given to the built-up column formed by nailing. A number of column types were built full size and tested, developing strength from 27 to 91 per cent of that of solid wood members. Short lengths did not materially diminish the strength. Two possibilities of great value are opened: (1) Replacement of solid columns of any required strength with somewhat larger columns built up of cheap material and (2) the mass production at the mill of long columns that are hard to obtain in solid material, for use as a whole or in sections.

Studies of built-up beams were begun. The objective in view is to obtain satisfactory members from units laid one above the other, so that high-class material need be used only toward the top and bottom where stresses are highest, inner layers being filled in with lumber of lower grade. The work has gone far enough to show that ordinary means of fastening are insufficient for the purpose, and gluing under the most carefully controlled conditions is now being tried. Studies of the laminated arch are planned with a view to encouraging large-scale production of efficient units, particularly for modern auditorium, factory, warehouse, and barn construction.

Closely allied with improved fabrication and construction methods as means toward holding and enlarging the structural market for wood is the securing of lasting and satisfactory service from wood in the completed building by proper grading, selection, and seasoning, and by measures that insure economical maintenance and good appearance.

Further analysis of the defects of commercial softwood lumber species gives a new and significant basis for selecting lumber to meet the requirements of specific uses. The findings of this study were assembled in mimeograph form and distributed to representative producers and associations for information and for use in grade revisions, pending preparation of a bulletin for general circulation. Species were classified as to the kind and prevalence of knots and the amount of pitch, shake, decay, stain, checking, and other defects as they occurred in 8-inch boards.

With the assistance of the laboratory, lumber producers made more progress this year than in any equal time before in bringing structural grades for the leading timber species into accord with Forest Service recommendations. This means that an engineer designing timber framework can detail sizes which have been definitely proved by test to be able to carry the required loads most economically with safety. A circular explaining the application of the recently adopted American lumber standards to the lumber purchased by the farmer, contractor, and home builder was published.

The most prolific source of trouble with lumber in ordinary service is the use of material seasoned to the wrong moisture content for the conditions it encounters. Natural adjustment causes excessive swelling and shrinking, with attendant damage such as weathering,

warping of panels, cracking or bulging of flooring, sticking of doors, and settling of framework. Steady progress was made in the various phases of the wood-seasoning and moisture-equilibrium problem—determining regional moisture conditions, improving standards of kiln-drying, devising instruments for the easy measurement of wood moisture, and studying methods of storage and handling to prevent undue moisture changes in stock after drying.

A report analyzing data obtained in the nation-wide survey of moisture content of wood in dwellings was completed for publication. With the aid of these data and weather maps it is now possible to plot the wood-moisture zones of the whole country at any season. Regional averages for wood moisture in houses and in house parts, from attic to cellar, have been determined. Further work is needed to apply this new information as a guide in mill and building practice, but if the conditions indicated are properly met the woodwork problem of the typical dwelling is permanently solved. Incidentally, it was proved that an increase of 8 per cent above the moisture content present at the time of construction is sufficient to ruin the most carefully laid floor, and that as a rule a change greater than 4 per cent should not be allowed.

The control of seasoning so as to reduce moisture variations and degrade of lumber was further studied. Particular attention was given to the internal and external physical factors that operate in the kiln-drying of Douglas fir, and drying schedules were worked out for wide clear material to secure rapid drying with minimum damage to stock. The data on several years' study of Douglas fir seasoning are now being analyzed and assembled for publication in bulletin form.

An experimental portable dry kiln was tested on two locations, with charges of southern pine. From the results of these runs it is probable that a practical kiln design can be developed for the use of small-mill operators, so that the large volume of lumber produced at these mills can be marketed in better and more salable condition.

That the laboratory's long advocacy of better seasoning is meeting with effective response throughout the industry was evidenced by many inquiries and requests for technical publications. Forced circulation as an important factor of kiln operation gained wider recognition. It was reported that one concern had manufactured and installed in kilns 10,000 internal fans of a design originated at the laboratory. Experiments demonstrating the efficacy of increased air movement in the drying of Douglas fir were instrumental in influencing producers to adopt this year the first moisture specification applying to that species. Many operators manifested interest in the "sliver machine," a simple apparatus recently developed for gaging moisture conditions in lumber seasoning and storage piles, and about 150 of these instruments were put in service. The "blinker" electrical machine for the quick determination of wood moisture, the technical development of which was completed a year ago, passed into commercial production at two manufacturing plants.

In the study of lumber storage and handling problems now in progress it is much easier to note examples of bad practice than to define the conditions that insure final delivery of material meeting

high market requirements. The first objective is to fix practical standards for shed storage. Measurements taken in the tall closed sheds of a western plant showed a humidity condition toward the bottom of the lumber stack sufficient to raise the moisture content of the better grades of stock to an undesirable degree. At the top, fluctuations of humidity corresponding to daily and seasonal variations of roof temperature occurred. These facts point to the desirability of some provision for heating and air circulation in tall sheds, for the better grades of lumber. Attention was given to the question of shed-roofing material, but no decisive difference was found between wood and metal in point of humidity effect. Studies of open and closed and of heated and unheated storage sheds were continued, and the scope of the work was broadened by the cooperation of additional producing and consuming plants.

Unmeasured commercial possibilities are bound up with antishrinkage treatments for wood, a study of which was started. An effective antishrink treatment of green material, besides simplifying wood drying, would fundamentally modify the shrinkage and swelling problem and its multiple variations. From the preliminary work within the limitations of the small funds available, interesting results were obtained. Experiments with impregnating chemicals were emphasized, with secondary attention to coatings and treatments to block moisture changes. A heavy impregnation with cane sugar reduced shrinkage about 50 per cent. Impregnation of wood with ammonia gas also showed a marked effect in controlling shrinkage and distortion. Not only empirical testing but largely augmented fundamental research on wood structure and composition ought to be directed to the solution of the shrinkage problem, in view of its far-reaching importance.

The effort toward better maintenance of wood in service included studies of decay prevention, painting, and fireproofing methods. The susceptibility of wood to damage by decay fungi, insects, and other harmful agencies has undoubtedly lessened the use of wood in house building and general construction. From inquiries received it appears that decay and termite infestation in buildings are increasingly serious problems. A new series of tests indicated that even blue stain, formerly regarded as not affecting strength, decreases the toughness of wood and reduces breaking and compressive strength in a considerable degree.

From the results of tests covering a period of many years a general law was formulated relating the toxicity, solubility, and chemical structure of preservatives. This accomplishment promises to lead to two important results: Prediction in advance of the preservative efficiency and service life of any given chemical, and the discovery or postulation of the "ideal" preservative composition, namely, one of maximum penetration and toxicity and of minimum leaching tendency. The degree to which any given chemical approximates this composition will then determine its preservative value. The findings of this study apply both to oils and to waterborne toxic materials. Since the latter are preferred for wood used in building, a scientific basis for judging the most satisfactory and practical preservative for use in the pretreatment of lumber has been provided. Incidentally, the laws applying to wood preserva-

tives appear to hold good for toxic materials in general, including those used in the control of crop pests and in the treatment of disease.

Six-year exposure tests have shown that the life of paints now generally used on wood is determined in large part by the characteristics of the wood itself. A leaflet was published explaining this relation and classifying American softwoods according to their paint-holding power. At the request of prominent paint technologists additional painted panels were exposed on test fences in the East, West, and South to determine the effectiveness of different priming coats. As a check on previous conclusions regarding the effect of extractives, a number of hemlock panels were exposed which had been treated with extractives of cypress, redwood, and western yellow pine before painting. Since hemlock wood is relatively free of extractives, the behavior of these "hybrid" panels should clearly isolate any effects due to extractives alone. Paint-adhesion studies of hardwoods were begun with the exposure of panels of 14 species, and a large number of softwood panels that had completed their life under test were received and examined.

Intensive studies were made of the fireproofing efficiency of five salts previously tested in a general way. These chemicals were injected into wood in varying amounts up to about 8 pounds of dry salt per cubic foot of wood, and the behavior of the treated wood in the fire tube was carefully studied. It is possible to give to wood, by any one of several treatments thus far examined, a degree of fire resistance adequate for many building purposes, but less expensive methods must be found to place the treated wood within reach of the average consumer. When this object is attained, one important factor contributing to the \$500,000,000 annual fire loss in the United States will be virtually eliminated, and there should be less discrimination in city building codes against wood as a fire hazard.

CONVERSION OF THE LOG INTO LUMBER

Economic stability and profit in forest growing and utilization require more efficient conversion of the stand into sawed products to meet the demands of established markets. The lines along which this problem is being attacked are selection of the tree for profitable cutting and sustained yield, improvement of mill practice, and the utilization of low-grade logs and little-used species.

An extensive survey of sawmill waste in the Douglas fir region was made by the Pacific Northwest Forest Experiment Station to determine the quantity and form of wood waste resulting from the manufacture of rough green lumber, and also the present utilization of this material. This survey showed that in 1929 the mills of western Oregon and Washington, in manufacturing 10,286,000,000 board feet of lumber, produced over 619,000,000 cubic feet (solid measure) of so-called sawmill waste. For every cubic foot of sound wood in the saw logs approximately $7\frac{1}{2}$ board feet of lumber was produced. Of the remaining material 44 per cent was reclaimed by the sawmills and sold as lath, handle squares, pulpwood, pulp chips, fuel wood, sawdust, etc.; 29 per cent was used by the sawmills as fuel in the production of power; and 27 per cent was sent to the burners and destroyed as true waste. The results of this survey will be published serially in a lumber journal.

A comprehensive report on logging-output studies was prepared for publication by the office of forest products in the Northern Rocky Mountain region. This reports covers a series of studies begun in 1923. It analyzes the effect of various factors on output and presents numerous carefully prepared graphs on sawing, horse skidding, tractor skidding, donkey skidding, loading, unloading, and various methods of transportation other than skidding.

A preliminary analysis of the results of the comprehensive woods and mill study in California by the California Forest Experiment Station indicated that it does not pay to saw lumber from western yellow-pine logs 14 inches and under in diameter, as the costs are greater than the value of the lumber. The study also indicates that sugar-pine logs 14 inches in diameter and under, white-fir logs 20 inches and under, and incense-cedar logs 13 inches and under can not be sawed into lumber at a profit.

Data obtained from logging and milling studies made in the second-growth loblolly pine and hardwood forests of the Atlantic coastal plain were analyzed, and the results of the work in Virginia are to be published in a bulletin by that State. The results of similar studies in the Gulf coast region were made ready for Government publication. Briefly, the findings are that it is much more costly to handle small trees than large ones, and that the lumber is worth less per thousand board feet when cut. Highest returns per acre are obtained when no trees less than 12 inches in diameter, are cut from Arkansas second-growth forest-grown shortleaf and loblolly pine; none less than 15 inches from Louisiana old-field loblolly; and from Virginia and North Carolina loblolly of the forest-grown and old-field types, none less than 12 inches and 11 inches, respectively. For virgin shortleaf in Texas and western Arkansas the diameters for greatest profit per acre were found to range from 10 to 14 inches, according to the type and the age of the stand. While a knowledge of cutting limits is of great value to the lumberman from the standpoint of operating profits, the most important use for the data is in developing practical plans for selective cutting as a means of introducing permanent forest management. The foregoing figures relate to utilization for lumber only. Studies to follow will embrace second-growth stands of longleaf and slash pine in which lumber cutting is supplementary to turpentine and pulp production.

Direct correlations between lumber values and silvicultural factors were worked out in the North Carolina loblolly pine stand. There it was found that plots with the greatest and the smallest density of stocking gave respectively the lowest and next to the lowest return per acre; in the one case logging costs were high because of small trees, in the other lumber grades and values were low because the open spacing induced heavy growth of limbs. The percentage of high-grade lumber was influenced also by the proportion of hardwoods present. The highest percentage of B and Better pine lumber came from a stand of intermediate density in which the basal area of hardwoods was about one-third the total basal area. These and other relations bear directly on the profitableness of silvicultural methods such as planting, thinning, and, possibly, pruning.

Work toward improving the methods and products of the small mill took on added interest with the study of a portable band mill of advanced type on a North Carolina operation. The whole mill,

with efficient log-handling and carriage equipment and a band saw cutting a $\frac{3}{32}$ -inch kerf, is mounted on a standard-gage flat car and moved by rail to advantageous locations as logging proceeds. From actual measurement and grading of its output it was shown that such a mill will average about \$7 per thousand board feet, log scale, better gross returns than a large stationary band mill operating on the same class of material, and \$10 better returns than a portable circular mill.

Several chapters were completed for a proposed loose-leaf handbook for small-mill operators. These deal principally with machinery adjustments for more uniform sawing and with sound methods of cost finding. Progress was made in developing practical dip-tank equipment. This work supplements the notably successful research of the Bureau of Plant Industry on chemical dipping solutions to reduce blue staining of lumber. Work on the portable kiln, previously mentioned, and on a grading stick for the use of the sawyer and edger man in improving the cut from hardwoods, are other features of the small-mill program which promise favorable developments.

Small-dimension stock apparently offers one of the most profitable forms into which low-grade and defective hardwoods can be converted. This type of material presents a special problem in New England. A study of the economics of small-dimension production from birch and maple was accordingly undertaken in that region. The results thus far indicate that bolts (short log sections) yield about 50 per cent more usable material on sawing than do logs, and that milling costs are 100 per cent higher for 5-inch than for 19-inch logs. Seasoning experiments in connection with this work showed definitely the allowances necessary in sawing to give any desired finished size. As part of the study, it is proposed to determine minimum sizes of logs that pay their way through the small-dimension mill and to compare the merits of the several milling systems in use. A departmental circular on the previous study of small-dimension stock from Lake States hardwoods was published and distributed throughout the industry.

Publications on the utilization of little-used species included a bulletin on the woods of Alaska, the first edition of which was quickly exhausted, a bulletin on properties and uses of Lake States aspen (issued cooperatively by the University of Minnesota), and a number of journal articles addressed to prospective users of chestnut. A bulletin on properties and uses of western larch was prepared for publication.

CHEMICAL CONVERSION OF THE TREE

The conversion of wood into useful commodities through pulping and other chemical processes holds out most challenging possibilities for the profitable utilization of little-used species, small and defective trees, and logging and milling wastes.

An entirely new plastic material appeared within reach as the result of treating partly hydrolyzed wood or sawdust with aldehydes such as furfural, itself a wood derivative. In formation and general properties, the new material seems analogous to the condensation products of aldehydes and phenols that have come into wide commercial and industrial use in the last decade. It can be

molded and sawed, it takes on a lustrous finish in the press, within certain limits it can be colored, it is dense and strong, and it has no appreciable tendency to swell or warp on exposure to moisture. The further study and development of this material will be actively followed up.

Pulping research is being conducted on a regional basis which accords with present economic trends. Among western woods, experiments with Douglas fir gave very satisfactory results. Good bleached pulps, suitable for book and bond papers, were produced by use of the laboratory's modified sulphate process. This procedure followed by a 2-stage bleaching, in which one stage is chlorination, met with considerable success in producing a white paper. Experimental sulphite pulping of Douglas fir yielded fairly satisfactory pulps of a bleachable character when the usual lime base was replaced by ammonia. Use of these bases involves a recovery system, details of which are being worked out under a special project.

Unless all signs fail, the results of laboratory research on the pulping of southern woods will soon find important application in large-scale commercial developments. Interest in this field is running high. Slash pine as a raw material for newsprint is attracting widespread attention. Experiments this year demonstrated that the commercial sulphite process gives satisfactory pulps from slash pine free of heartwood, and earlier investigations have shown that ground-wood pulp of satisfactory color and average strength can be produced from young slash pine with reasonable power expenditure. While rapid growth of the tree is eminently desirable for maximum volume of pulps, late studies prove that as a rule slow-grown material yields pulps of somewhat higher strength. Some compromise between extremes of growth is therefore in order.

For most commercial white papers resin-free wood is essential. A new pulping process developed by the laboratory may, however, effectively eliminate this requirement. It consists of a "semichemical" impregnation treatment of the wood with sodium sulphite and sodium bicarbonate, followed by ordinary calcium sulphite cooking. Applied to resinous longleaf and slash pines, it produced a strong bleachable pulp comparable in quality to standard sulphite. The horizon of usefulness as paper-making material not only for southern pines but also for a large group of northern and western species will be indefinitely widened if the new process, so successful experimentally, proves adaptable in practice.

The modified sulphate or kraft process gave an excellent account of itself when applied to slash pine, as was confidently expected from the experiments with loblolly and longleaf previously reported. Shortleaf and minor species of southern pine will comprise the next phase of this work.

Studies bearing on the technical control of paper making and the evaluation of paper and pulp were vigorously prosecuted, with the ultimate object of developing to the full the potentialities of any wood pulp under investigation as paper material. An important feature of the work was the installation on the laboratory paper machine of specially designed equipment to give positive control of all operating variables, including the speed of drive in all sections, press and calendar pressures, the temperature of stock and of driers, and shake frequency. Further development of screen-

analysis methods resulted in a significant correlation between fiber length and pulp quality. Apparatus for pore-volume measurement was improved in accuracy and used in a number of cases for the evaluation of papers.

WOOD, THE RAW MATERIAL

The successful adaptation of any raw material to diversified markets and its transformation into new products generally requires an increasing knowledge of the material itself. With wood this is an exceptionally difficult matter because of the variability and complexity of its substance as a chemical and biological aggregate. Nevertheless a very useful general picture has been built up. Last year brought significant additions to knowledge of the composition, structure, development, and properties of the material.

Progress in the production of a new plastic from wood by treatment with aldehydes has been described. A curious feature of this study was the creation of a similar plastic by the treatment of hydrolyzed or unhydrolyzed wood with phenols; that is, either component of commercial plastics now widely used will combine with wood to make a similar product. Whether considered as a clue to wood composition or an added complexity, this finding commands further attention.

The effects of heat and cold in the chemical isolation of lignin from wood were studied. Evidence indicates that much of the lignin obtained at ordinary or high temperature by accepted methods consists of impurities or degradation products from cellulose that add complications to the study of a practically unknown compound. Isolation of lignin at reduced temperature gave a smaller amount of material, regarded as much purer. Its lighter color approximates that of the original wood.

The X ray was used in a study of the development of cell structure in the living tree. The work has proceeded only far enough to show how sharply the cellular or quasi-crystalline formation is confined to the wood and bark outside the thin layer in which the growth process is at work. The search for transitional material, if successful, should furnish useful data for the physical and organic chemist in working out the molecular arrangement and composition of cellulose.

Research on wood extractives included a careful determination of the resin content of young slash pine, which clarified the problem of pulping this species. While the average proportion of resin in the young tree is not high, there is a marked increase of resin toward the center, causing pulping difficulties that would not occur if the distribution were more uniform. Sufficient resin to cause trouble was found in slash pines 30 years old, even though no true heartwood had been formed. The study showed rather definitely why a higher percentage of screenings result in the sulphite and mechanical processes of pulping slash pine, and suggests that these processes might better be restricted to even younger trees.

Considering the extractive from the opposite standpoint of naval-stores production, a careful analysis of the oleoresin of slash pine was made as the first step in a thorough study of biochemical factors which influence oleoresin formation, in quality and quantity. In the course of the experiments information on water extractives and

oxidation products of the resin that effect its commercial grading was obtained. In a further study of the extractives of western red cedar an organic acid was isolated which may account entirely for the corrosive effect of this wood on certain metals. Three extractive compounds derived in series from redwood were also identified and named, and their chemical kinship to other wood extractives was established.

With a view to facilitating the movement of liquids through wood, an attempt was made to enlarge the effective cross section of the minute openings in the pit membranes of the wood cell, which are the seat of the major resistance to flow. A drastic treatment of short specimens of Sitka spruce with moist chlorine gas followed by treatment with ammonia gave more than a hundredfold increase in permeability but practically destroyed the strength of the wood. Less drastic treatment gave a thirtyfold increase in permeability and only a slight reduction in strength. Treatment of Douglas fir specimens a foot long increased permeability two to five times. The process has possible application to the impregnation of difficult woods with chemicals, as in preservation and pulping.

A bulletin summarizing the laboratory's studies of wood-liquid relations, covering hygroscopicity, capillarity, and rate of diffusion and drying, was prepared for publication.

Further progress was made in relating the properties of wood to conditions of growth, structure, and service. Mechanical properties have been accurately related to moisture content, and a revision is now under way of the laboratory's data on mechanical properties, referring all strength values to a moisture content of 12 per cent, which represents an average air-dry condition of the wood. The number of species covered by the data will be increased from 116 to 160 as the result of recent tests. In a study of regional influences on properties of wood, no significant difference was noted in the strength of Sitka spruce and Douglas fir grown in Oregon as compared with that of the same species grown in Alaska, whereas considerable differences in strength were found between Douglas fir of the coastal type and of the mountain type.

This confirms the view that mere geographical location of the stand is of no weight in comparison with immediate silvicultural factors as an indication of the strength of wood. The effect of site conditions was strikingly illustrated in the case of a 25-year-old planting of pines in a sandy location. Cuttings from the stand revealed extraordinary weakness and brashness, and an examination of the wood showed poor and irregular development of the summer-wood bands. This example points to the need of carefully appraising the effect of environmental factors on quality as well as quantity of yield before embarking on any large adventure in artificial reforestation.

By examining and testing a large number of samples of normal and abnormal material it was possible to work out a general law relating the longitudinal shrinkage of wood to its structural characteristics. In normal wood, in which the fibrils approach parallelism with the fiber axis, longitudinal shrinkage decreases as specific gravity increases, until in extremely dense material a slight "negative shrinkage" (elongation) occurs on drying. In material of the compression-wood type, in which the fibrils have a pronounced slope

with respect to the fiber axis, increasing specific gravity brings with it progressively greater shrinkage lengthwise. Thus high specific gravity, which is generally a test of excellence, falls under suspicion in cases where the material contains compression wood or similar growth, a fact which makes visual detection of the abnormality all the more important.

An interesting confirmation of the theory that leaning trees are a frequent source of compression wood was afforded by certain pine trees that had been subjected to the Florida hurricane of September, 1926. About one-third of the sample trees cut from the stand in question were found to have produced heavy compression-wood growth on one side of the 1926 annual ring, and decreasing amounts in rings of succeeding years. Since most of the compression wood was found in the upper part of the stems, the inference is justified that the storm, whipping over the tops, caused severe bending, which the trees gradually corrected by the formation of compression wood as a brace. The action of winds from various directions would, in general, account for the sporadic formation of compression wood observed in the cross section of many trees.

A bulletin on brashness in wood, summarizing several years' studies of this major defect, was prepared for publication. The occurrence of brashness may be due to any one of several causes, among which the bulletin notes compression wood, compression failures, low density, and incipient decay. Methods of visual detection of brash material are explained.

A mathematical analysis of the elastic behavior of wood as a non-isotropic material was begun. This study is intended to correct some very common engineering assumptions by correlating the stresses and strains of wood directly with its structure in concentric layers, a formation which acts very differently from a uniform body.

RANGE INVESTIGATIONS

An analysis during the year by the Intermountain Forest and Range Experiment Station, of data accumulated during 15 years of study of the restoration of depleted mountain range lands in central Utah, shows a close relationship between the depletion of the soil, following destruction of vegetation by overgrazing, and the ability of the range to recover. Areas on which the soil was badly depleted in 1915, and which at that time produced chiefly annual weeds, required about 36 acres to support a cow for a month. These areas now produce a scant stand of grasses and a rather good stand of other herbaceous perennials, but still require nearly 10 acres to support a cow one month. Areas on which the soil was only moderately depleted and on which some grasses remained 15 years ago, now produce a fair stand of grass and a good stand of other perennial herbs, and require $3\frac{1}{2}$ acres to support a cow a month. On areas where neither soil nor forage was depleted 15 years ago the more palatable plants have been maintained, and only 2 acres are required to support a cow for a month.

Sowings of several cultivated forage plants which had been made several years ago in the oak-brush zone of central Utah by the Intermountain station in cooperation with the Bureau of Plant Industry, reached sufficient maturity to demonstrate their ability to establish themselves under the semiarid conditions prevailing. Up to an alti-

tude of 8,000 feet the yellow sweetclovers produced good stands of vigorous plants, bloomed early, and matured seed. The best stands were produced from seed sown in furrows plowed along the contour of the slope. Substantial foliage production was made in spite of constant grazing by cattle and rodents. Similarly, crested wheatgrass proved a vigorous, rapid-growing, and drought-resistant species, which starts early in the spring, remains green until late in the fall, and withstands heavy grazing remarkably well. White sweetclover, however, was unable to withstand grazing under the dry conditions prevailing on the test areas.

The exploratory studies of spring-fall ranges in the intermountain region, authorized by the McSweeney Act, showed that considerable range values have been destroyed during the 50 to 60 years that these lands have been grazed. Three striking differences in the nature and amount of the plant cover on the ranges were revealed: (1) In areas protected from both fire and grazing for a number of years approximately four-tenths of the soil is covered with vegetation of which the native wheatgrasses and bluegrasses constitute 68 per cent and sagebrush only 11 per cent; (2) burned but ungrazed tracts also have about four-tenths of their soil surface covered with vegetation which, however, consists of only two-thirds as much perennial grass cover and one-fifth as much sagebrush as are found on the protected areas, while annual grasses having little grazing value constitute 22 per cent of the total plant cover; (3) tracts which have been grazed but which have not been burned support a vegetative cover only slightly less abundant than that of the protective area, but they furnish only three-fifths as great a grazing capacity; their vegetation consists of less than three-fifths as much perennial grass cover as in the protected areas, more than twice as much sagebrush, and a materially larger stand of annual grasses.

The results of management studies of spring-fall range in southern Idaho, in cooperation with the Bureau of Animal Industry, which have been under way for seven years, were analyzed last year. Range grazed continuously for three weeks, beginning with the start of plant growth in the spring, had lost 62 per cent of its grazing capacity, and similar range grazed during the entire spring period had lost 75 per cent. Corresponding decreases took place in the surface cover of perennial grasses and other palatable plants, whereas sagebrush increased. On the other hand, range grazed for 10 days in the spring after the palatable plants had made vigorous growth and in the fall sufficiently to make full use of the forage then available, maintained a high grazing capacity, and practically no change took place in the composition and extent of the cover, though a number of the seven years were unusually dry. Conservative grazing of the range only in the fall increased the stand of grasses and other palatable plants, while a slight decrease took place in the sagebrush cover. Such fall grazing affords the maximum opportunity for improvement of depleted ranges in the sagebrush-wheatgrass type of spring-fall range.

Interesting results on injury by livestock to western yellow-pine reproduction of different sizes were brought to light by studies of the Southwestern Forest and Range Experiment Station, authorized by the McSweeney Act. On cattle range, in one year, 4.3 per cent of the reproduction advanced beyond the seedling stage was injured

by grazing. Of 2-year-old seedlings, 14 per cent were injured and 3 per cent were killed, and of those 1 year old, 5 per cent were injured and 7 per cent killed. On sheep range, 7.3 per cent of the advance reproduction was injured by grazing; of 2-year-old seedlings, 8 per cent were injured and 1 per cent killed, and of 1-year-old seedlings, 5.1 per cent were injured and 2 per cent killed. In addition, 45 per cent of the year-old seedlings and over 15 per cent of the 2-year-old seedlings died from natural causes—a very heavy loss. These results emphasize the importance of developing effective range management methods.

The report on studies, mentioned last year, of plant succession on clay soils on the Jornada Experimental Range of the Southwestern station, in New Mexico, was completed. Drought, overgrazing, erosion by wind and water, and rodent damage are all factors in the depletion of range forage on clay soils. In the natural restoration annual and perennial weeds are the first usable plants to come in on denuded spots. Burro grass, a prolific-seeding perennial whose seeds work readily into the clay soils by long awns and which also spreads by means of stolons, or horizontal stems, that extend out from the tufts and take root to establish new plants, also appears on denuded soils, but usually follows the establishment of weeds. Because of the low feed value of these plants the grazing capacity of the early stages of succession is low. This vegetation, however, improves the humus content and water-holding capacity of the soil, thus aiding the re-establishment of plants of higher grazing value. The best stages of development are characterized by a good plant cover, dominance of tobosa grass, and range which on the average will support a cow for a month on about 31½ acres.

EXPENDITURES AND RECEIPTS

The expenditures for all purposes during the fiscal year were as follows:

General administration	\$368, 860. 05
Forestry extension	78, 846. 88
Research:	
Silvical investigations	\$899, 045. 72
Forest products investigations	693, 632. 41
Range investigations	125, 042. 01
Taxation study	65, 642. 55
Total	1, 783, 362. 69
Administration, protection, improvement, reforestation and extension of the national forests:	
Administration—	
Timber use	\$998, 219. 47
Grazing use	1, 016, 234. 22
Fish and game protection	145, 252. 80
Recreation and land use	260, 513. 33
Examination and administration of power sites for Federal Power Commission	24, 664. 00
Classification, settlement, and claims	95, 454. 98
General surveys and maps	180, 051. 46
Grazing reconnaissance	96, 359. 05
Timber surveys	234, 898. 09
Subtotal	3, 051, 647. 40

Administration, etc.—Continued.

Protection—

Fire prevention and detection.....	\$2, 363, 442. 73	
Fire suppression.....	2, 056, 744. 16	
Protection against insects and tree diseases.....	462, 650. 79	
Subtotal.....		\$4, 882, 837. 68

Improvement—

Construction of improvements other than roads, trails, and camp-ground improvements.....	1, 884, 012. 52	
Maintenance of improvements other than roads, trails, and camp-ground improvements.....	722, 014. 74	
Camp-ground improvements.....	100, 000. 00	
Construction and maintenance of roads and trails—		
10 per cent fund under act of Mar. 4, 1913.....	763, 031. 69	
Cooperative construction of roads and trails under act of July 11, 1916.....	51, 565. 64	
Emergency construction, act of Dec. 20, 1930....	3, 052, 616. 19	
Highways within national forests, act of Dec. 20, 1930.....	899, 326. 37	
Forest development roads and trails under act of Nov. 9, 1921.....	3, 118, 491. 16	
Forest highways under act of Nov. 9, 1921.....	7, 654, 564. 59	
Road and trail construction from moneys contributed by cooperating agencies under act of June 30, 1914.....	1, 927, 882. 33	
Contributed from other appropriations.....	1, 288, 843. 44	
Class total (roads) ..	18, 756, 321. 41	
Subtotal.....		21, 462, 348. 67

Reforestation—

Nurseries and tree planting..... 286, 280. 01

Extension—

Land exchanges..... 151, 089. 04

Acquisition under act of Mar. 1, 1911, as amended..... 2, 014, 411. 01

Subtotal..... 2, 451, 780. 06

Total.....\$31, 848, 613. 81

Protection and reforestation of other than national forest lands:

Tree planting in cooperation with States under act of June 7, 1924..... 90, 798. 16

Fire protection in cooperation with States under act of June 7, 1924..... 1, 633, 050. 18

Protection of Oregon and California grant lands..... 74, 276. 50

Total..... 1, 798, 124. 84

Grand total..... 35, 877, 808. 27

In addition to the expenditure for land extension itemized above in the entries "land exchanges" and "acquisition under act of March 1, 1911," national-forest timber having an estimated value of \$461,323 was cut under agreements involving the acquisition of land and timber through exchange. The cash disbursements recorded under "land exchanges" cover merely the outlay incidental to examining lands offered for exchange and appraising the values involved.

The cash receipts from the national forests were as follows:

From the use of timber-----	\$2, 607, 617. 70
From the use of forage-----	1, 960, 642. 32
From miscellaneous uses, including the use of land, water-power sites, etc -----	425, 060. 06
<hr/>	<hr/>
Total-----	4, 993, 320. 08

The total is less by \$1,758,233.14 than that for the previous year. Receipts from timber decreased \$1,782,275.30. Grazing receipts were greater by \$17,728.13 and miscellaneous receipts increased \$6,314.03.

In addition to the cash receipts from timber, there should be credited the value of the timber cut under specific agreements for effecting land exchanges, estimated at \$461,323.



REPORT OF THE CHIEF OF THE GRAIN FUTURES ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
GRAIN FUTURES ADMINISTRATION,
Washington, D. C., September 1, 1931.

SIR: I submit herewith a report of the work of the Grain Futures Administration for the fiscal year ended June 30, 1931.

Respectfully,

J. W. T. DUVEL, *Chief.*

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

The volume of futures trading in grain on all of the contract markets, combined, aggregated 17,034,201,000 bushels during the last fiscal year. This is the smallest yearly aggregate since the fiscal year ended June 30, 1924, and the second smallest total volume of any year during the 10 years for which volume-of-trading records have been compiled by the administration, and is a striking decline from the 24,999,650,000-bushel aggregate recorded during the fiscal year ended June 30, 1930.

The greatest decline in the volume of trading occurred in the wheat futures with total sales of 10,063,139,000 bushels. This is nearly 50 per cent less than the total trading in wheat for the previous year but exceeds the low record of 1923-24 by about 38 per cent. The decrease in the volume of trading in wheat futures was due in part to increased speculative interest in corn as a result of a much closer adjustment between the supply and demand for corn than for wheat. Stocks of wheat were abundant and burdensome, being the largest of record, whereas the supply of corn was abnormally short, the crop of 1930 being the smallest since 1901 and more than 20 per cent below the crop of 1929 and 26 per cent below the crop of 1928. This greater incentive to speculation in corn is reflected in an increase of 50 per cent in the volume of trading in corn futures over the previous year.

The support given to the wheat market by the Grain Stabilization Corporation, functioning under the auspices of the Federal Farm Board, naturally had a bearing on the volume of trading in wheat futures. The limited foreign demand for wheat, the unsettled condition of the stock market, and the world-wide uncertainty as to the progress of business generally also were factors of vital importance. In fact, the decrease in the number of shares of stock sold on the New York Stock Exchange was more pronounced than the decrease in the combined volume of trading in grain futures on the various grain exchanges. In comparison with the previous year the shares of stock sold decreased a little more than 38 per cent whereas the

combined trading in grain futures decreased slightly less than 32 per cent.

The largest volume of trading for any one day of the year occurred August 6, 1930, when sales of all grain futures on the Chicago Board of Trade aggregated 180,127,000 bushels. The total volume of trading in all grain futures on the Chicago Board of Trade for the fiscal year was 14,504,786,000 bushels.

The aggregate annual volume of trading in wheat, corn, oats, rye, barley, and flax futures for each of the contract markets during the year just closed is shown in Table 1. Table 2 presents the average, maximum, and minimum daily volume of trading in each grain future, and in all futures combined, on the Chicago Board of Trade during the fiscal year, together with the respective dates. Tables 3 and 4 present the monthly volume of trading in wheat and corn futures on each contract market where these futures were traded in during the past year.

TABLE 1.—*Total volume of trading in wheat, corn, oats, rye, barley, flax, and all grain futures combined on the contract markets, fiscal year ended June 30, 1931*

[In thousands of bushels; i. e., 000 omitted]

Market	Wheat	Corn	Oats	Rye	Barley	Flax	All grains
Chicago Board of Trade.....	8,360,329	5,040,966	740,699	362,792	-----	-----	14,504,786
Chicago Open Board of Trade....	296,829	170,866	4,984	283	-----	-----	472,962
Minneapolis Chamber of Commerce ¹	580,981	9,709	88,208	96,361	80,347	20,292	875,898
Kansas City Board of Trade.....	515,495	250,624	165	-----	-----	-----	766,284
Duluth Board of Trade.....	219,691	-----	-----	34,025	1,155	24,484	279,355
St. Louis Merchants Exchange.....	8,792	3,812	-----	-----	-----	-----	12,604
Milwaukee Chamber of Commerce.....	15,329	28,406	7,559	4,571	-----	-----	55,865
New York Produce Exchange ²	25,435	-----	-----	-----	-----	-----	25,435
Seattle Grain Exchange.....	12,207	-----	-----	-----	-----	-----	12,207
Portland Grain Exchange.....	12,753	-----	-----	-----	-----	-----	12,753
Omaha Grain Exchange.....	15,298	740	2	-----	-----	-----	16,040
San Francisco Chamber of Commerce.....	-----	-----	-----	-----	12	-----	12
Total.....	10,063,139	5,505,123	841,617	498,032	81,514	44,776	17,034,201
Percentage of total trading done on Chicago Board of Trade.....	83.08	91.57	88.00	72.85	-----	-----	85.15

¹ Trading in corn futures on the Minneapolis Chamber of Commerce was resumed Jan. 31, 1931.

² Trading in bonded Canadian wheat futures on the New York Produce Exchange was resumed Mar. 3, 1931.

TABLE 2.—*Average, maximum, and minimum daily volume of trading in grain futures on the Chicago Board of Trade during the fiscal year ended June 30, 1931, with dates of largest and smallest day's trading in each grain future*

[In thousands of bushels; i. e., 000 omitted]

Grain	Average daily volume of trading	Largest volume of trading in single day		Smallest volume of trading in single day	
Wheat.....	27,961	118,320	Aug. 6, 1930	5,131	Mar. 21, 1931
Corn.....	16,859	45,340	-----do-----	2,997	June 13, 1931
Oats.....	2,477	11,858	-----do-----	304	Do.
Rye.....	1,213	6,148	Aug. 29, 1930	47	Mar. 19, 1931
All grains.....	48,510	180,127	Aug. 6, 1930	10,313	Mar. 21, 1931

TABLE 3.—*Monthly volume of trading in wheat futures on each of the contract markets during the fiscal year ended June 30, 1931*

[In thousands of bushels; i. e., 000 omitted]

Market	July, 1930	August, 1930	Septem- ber, 1930	October, 1930	Novem- ber, 1930	Decem- ber, 1930
Chicago Board of Trade.....	1, 129, 477	1, 264, 207	1, 011, 822	967, 016	887, 796	418, 660
Chicago Open Board of Trade.....	31, 847	34, 931	31, 677	33, 670	24, 019	8, 484
Minneapolis Chamber of Commerce.....	49, 559	103, 638	74, 439	74, 553	81, 945	45, 044
Kansas City Board of Trade.....	78, 805	82, 103	58, 272	53, 546	66, 096	38, 513
Duluth Board of Trade.....	12, 136	39, 592	35, 419	26, 726	28, 066	15, 388
St. Louis Merchants Exchange.....	891	1, 184	458	1, 597	1, 570	360
Milwaukee Chamber of Commerce.....	2, 215	2, 203	1, 694	1, 543	1, 972	920
Omaha Grain Exchange.....	51	26	79	1	24	111
Seattle Grain Exchange.....	593	1, 432	1, 340	812	1, 422	602
Portland Grain Exchange.....	377	1, 598	890	580	1, 238	1, 174
New York Produce Exchange ¹						

Market	January, 1931	February, 1931	March, 1931	April, 1931	May, 1931	June, 1931
Chicago Board of Trade.....	288, 971	320, 346	365, 558	558, 811	534, 567	613, 098
Chicago Open Board of Trade.....	12, 424	13, 448	16, 406	30, 479	29, 034	30, 410
Minneapolis Chamber of Commerce.....	18, 300	13, 627	15, 671	47, 401	18, 028	38, 776
Kansas City Board of Trade.....	12, 752	12, 402	15, 058	35, 817	24, 019	38, 112
Duluth Board of Trade.....	10, 027	5, 625	6, 437	19, 557	8, 660	12, 058
St. Louis Merchants Exchange.....	170	60	110	1, 870	326	196
Milwaukee Chamber of Commerce.....	602	827	709	878	787	979
Omaha Grain Exchange.....	682	1, 521	3, 148	991	8, 654	10
Seattle Grain Exchange.....	1, 249	982	706	645	2, 242	182
Portland Grain Exchange.....	1, 529	730	1, 202	840	2, 285	310
New York Produce Exchange ¹			7, 995	8, 375	6, 115	2, 950

¹ Trading in bonded Canadian wheat in New York began Mar. 3, 1931.TABLE 4.—*Monthly volume of trading in corn futures on each of the contract markets during the fiscal year ended June 30, 1931*

[In thousands of bushels; i. e., 000 omitted]

Market	July, 1930	August, 1930	Septem- ber, 1930	October, 1930	Novem- ber, 1930	Decem- ber, 1930
Chicago Board of Trade.....	464, 695	571, 477	404, 731	429, 448	381, 025	588, 129
Chicago Open Board of Trade.....	10, 653	11, 572	9, 581	9, 639	10, 371	26, 296
Kansas City Board of Trade.....	20, 520	24, 901	15, 347	19, 503	23, 534	30, 736
St. Louis Merchants Exchange.....	280	463	566	218	506	325
Milwaukee Chamber of Commerce.....	2, 333	2, 585	2, 482	2, 305	2, 406	3, 790
Omaha Grain Exchange.....	72	5		35	76	135
Minneapolis Chamber of Commerce ¹						

Market	January, 1931	Febru- ary, 1931	March 1931	April, 1931	May, 1931	June, 1931
Chicago Board of Trade.....	542, 024	427, 140	329, 542	341, 511	317, 167	244, 077
Chicago Open Board of Trade.....	27, 653	19, 515	16, 909	10, 793	9, 600	8, 284
Kansas City Board of Trade.....	27, 041	20, 686	17, 738	23, 104	17, 079	10, 435
St. Louis Merchants Exchange.....	427	291	230	347	140	19
Milwaukee Chamber of Commerce.....	2, 869	2, 207	2, 079	2, 317	1, 379	1, 654
Omaha Grain Exchange.....	95	65	62	130	55	10
Minneapolis Chamber of Commerce ¹	40	3, 783	3, 440	1, 713	457	276

¹ Trading in corn futures on the Minneapolis Chamber of Commerce was resumed Jan. 31, 1931.

FIELD OFFICES ESTABLISHED

During the year field offices of the administration were established at Omaha, Nebr., and New York, N. Y., the Omaha Grain Exchange having inaugurated futures trading as a contract market, under the grain futures act, on June 16, 1930, and the New York Produce Exchange having resumed trading in bonded Canadian wheat futures on March 3, 1931, after a 3-year period of inactivity as a grain-futures market. The present futures market of the New York Produce Exchange is unique in that trading is confined solely to Canadian wheat deliverable in bonded warehouses in Buffalo, N. Y.

OPEN COMMITMENTS ANNOUNCED

The daily announcement by the administration of the amount of contracts open in each grain future on the books of all clearing members of the principal contract markets, as well as the volume of trading, was continued during the year. The amount of open commitments in each important Chicago wheat future traded in on the Chicago Board of Trade, during the fiscal year, is shown by semi-monthly periods in Table 5. Table 6 presents similar data pertaining to Chicago corn futures.

TABLE 5.—Open commitments in each wheat future on the Chicago Board of Trade, shown semimonthly for the period June 30, 1930, to June 30, 1931¹

[In thousands of bushels; i. e., 000 omitted]

Date	Future						All wheat futures
	July	Septem- ber	Decem- ber	March	May	Other	
1930							
June 30	14, 082	55, 597	35, 492				105, 171
July 15	4, 235	61, 382	43, 755	218			109, 590
July 31		65, 772	57, 128	3, 326			126, 226
Aug. 15		41, 194	86, 330	6, 605	8, 695		142, 824
Aug. 29		13, 948	98, 305	8, 988	21, 132		142, 373
Sept. 15		2, 919	109, 129	11, 614	38, 785		162, 447
Sept. 30			99, 190	14, 474	53, 664		167, 328
Oct. 15	1, 518		92, 957	15, 301	64, 388		174, 164
Oct. 31	2, 098		89, 410	16, 926	76, 851		185, 285
Nov. 15	4, 331		67, 189	17, 891	94, 721		184, 132
Nov. 29	10, 237		28, 536	17, 774	103, 995		160, 542
Dec. 15	17, 105	5	5, 319	15, 886	116, 910		155, 225
Dec. 31	27, 238	5		10, 908	106, 501	40	144, 692
1931							
Jan. 15	27, 610	10		9, 120	95, 408	45	132, 193
Jan. 31	29, 795	165		9, 515	93, 998	45	133, 518
Feb. 14	28, 200	3, 899		9, 429	91, 277	45	132, 850
Feb. 28	31, 976	7, 031		10, 018	85, 662	45	134, 732
Mar. 14	33, 394	9, 397		4, 090	83, 136	75	130, 092
Mar. 31	36, 680	13, 922			75, 989	840	127, 431
Apr. 15	34, 836	16, 298	3, 318		70, 584	820	125, 856
Apr. 30	34, 946	21, 125	6, 752		51, 127	840	114, 790
May 15	33, 457	22, 317	8, 294		28, 115	830	93, 013
May 29	32, 179	25, 649	11, 759			850	70, 437
June 15	30, 767	30, 410	16, 325			840	78, 342
June 30	17, 711	39, 501	21, 463			² 130	78, 805

¹ The maximum open commitments in all wheat futures was 188,527,000 bushels on Nov. 3, 1930. The minimum was 70,437,000 bushels on May 29, 1931.

² Quantity of June wheat contracts defaulted.

TABLE 6.—Open commitments in each corn future on the Chicago Board of Trade, shown semimonthly for the period June 30, 1930, to June 30, 1931¹

[In thousands of bushels; i. e., 000 omitted]

Date	Future					
	July	Septem-ber	Decem-ber	March	May	All corn futures
1930						
June 30	10,924	18,610	8,372			37,906
July 15	5,703	18,832	10,874			35,409
July 31		18,024	24,038	2,165		44,227
Aug. 15		11,692	29,123	4,906	2,559	48,280
Aug. 29		8,279	32,219	5,672	4,841	51,011
Sept. 15		4,454	30,767	6,154	7,022	48,397
Sept. 30			27,775	6,191	16,356	50,322
Oct. 15	394		26,435	7,503	16,244	50,576
Oct. 31	1,209		25,605	7,965	20,997	55,776
Nov. 15	2,282		20,672	8,045	25,748	56,747
Nov. 29	3,522		11,597	8,007	31,081	54,207
Dec. 15	5,293		3,846	7,039	38,849	55,027
Dec. 31	7,153	10		6,507	40,110	53,780
1931						
Jan. 15	9,638	166		5,575	40,872	56,251
Jan. 31	11,788	1,734		4,664	40,433	58,619
Feb. 14	12,051	2,911		4,558	38,630	58,150
Feb. 28	13,476	4,183		3,012	37,877	58,548
Mar. 14	15,606	4,395		1,835	35,084	56,920
Mar. 31	16,393	6,931			32,785	56,109
Apr. 15	16,360	8,099	1,972		27,986	54,417
Apr. 30	18,627	11,174	3,979		9,325	43,105
May 15	20,361	12,110	5,750		4,744	42,965
May 29	20,680	12,835	6,192			39,707
June 15	20,142	13,960	6,965			41,067
June 30	14,701	15,078	10,504			40,283

¹ The maximum open commitments in all corn futures was 59,172,000 bushels on Jan. 24, 1931. The minimum was 35,409,000 bushels on July 15, 1930.

AMERICAN PRICE STABILIZED ABOVE WORLD PRICE

Although the fiscal year saw the lowest wheat-price quotations recorded on the Chicago Board of Trade in approximately 35 years, ascribed to the tremendous world's oversupply of wheat, and the world-wide economic depression, the emergency operations of the Grain Stabilization Corporation which began on November 17, 1930, and continued until June, 1931, held domestic futures prices and cash prices of the 1930 American wheat crop at from 20 to 35 cents a bushel above the usual Chicago-Liverpool price relationship during this 6½-month period. These price-stabilization operations were of vast benefit to those who were thereby enabled to market their wheat holdings at the stabilized domestic price.

Investigations by the administration at several contract markets disclosed that the holders of small futures accounts, designated by the trade as the "country," during the year just closed, as in the past, were preponderantly on the long side of the wheat-futures market as contrasted with the larger, or professional speculative traders, who operated primarily on the short side of the market. For instance, surveys made at intervals during the year at the Kansas City futures market disclosed that during the first half of the year 91 to 93 per cent of all speculative wheat-futures accounts on the books of the private-wire houses at that market were on the long side of the market, and that during the last half of the year from 77 to 82 per cent of all such accounts were on the long side.

RUSSIAN WHEAT-FUTURES SALES

In September, 1930, agents of the Grain Futures Administration investigating rumors current in trade circles, found that the All-Russian Textile Syndicate (supported by the Soviet Government) had placed orders in New York City with three nonclearing members of the Chicago Board of Trade for the sale of Chicago wheat futures aggregating 7,765,000 bushels. While these selling orders were executed on the Chicago Board of Trade over a 4-day period, September 8 to 11 inclusive, 92.7 per cent of the total sales were made on September 10 and 11, and on these two days they comprised approximately 28 per cent and 19 per cent, respectively, of the total daily sales of all wheat futures combined on the board of trade, excluding sale by "scalpers"—those traders who individually buy and sell the same quantity of futures during the trading day, and are "even" in the market at the close of the day's business.

The open wheat-futures commitments on the Chicago Board of Trade during the 4-day Russian-sales period increased from 147,982,000 bushels to 158,317,000 bushels, an increase of 10,335,000 bushels. The Russian sales, alone, were responsible for 75.1 per cent of the total increase. During this 4-day period the price of the Chicago December wheat future declined from a high of 92% cents per bushel on September 8 to a low of 86½ cents on September 11, a loss of 6½ cents. The March future declined from a high of 96½ cents on September 8 to a low of 90% cents on September 11, a loss of 6½ cents. The May future declined from a high of 99½ cents on September 8 to a low of 93% cents on September 11, a loss of 5¼ cents.

As stated, these Russian orders were placed with three New York City commission houses, nonclearing members of the Chicago Board of Trade. Investigation by administration accountants disclosed that one of these firms which was instructed to sell a total of 2,365,000 bushels, in turn placed its selling orders with three different commission houses in Chicago. The second New York firm was instructed to sell a total of 2,300,000 bushels. It placed its orders with another commission house in Chicago. The third New York house, which was instructed to sell 3,100,000 bushels, arranged for the actual execution of its orders by five different commission houses in Chicago.

In recognition of the extremely dangerous potentialities of such selling operations in the American grain-futures markets by a foreign Government, the directors of the Chicago Board of Trade on September 26, 1930, unanimously adopted a resolution condemning such activities and declaring:

* * * It is the conclusion of the Board that the selling of futures upon our exchanges by any foreign government is a new development of commerce of seriously objectionable character and it must be brought to an end. * * *

TRANSMISSION OF A SPURIOUS TELEGRAM

During the year a special inquiry was instituted by the administration into the circumstances surrounding the transmission on September 23, 1930, of a telegram from Winnipeg to Chicago, containing utterly false information relative to the alleged financial difficulties of the Canadian wheat pool. Investigation disclosed that the tele-

gram was filed by telephone with the Canadian Pacific Telegraph Co. in Winnipeg, and dispatched to two futures commission houses in Chicago, and to the Liverpool Corn Exchange. The spurious message purported to bear the signature of a prominent Winnipeg grain firm, and its contents were disseminated widely over the private telegraph wires of many Chicago commission houses before its spurious character became known. Although the authenticity of the message was denied before the opening of the market, buying confidence was weakened greatly and the dominant (December) wheat future declined from the close of 84¾ cents on the preceding day to a low of 82¼ cents on the day of the dissemination of the forged telegram, a loss of 2½ cents. A reward of \$1,000 for the identification of the person who filed the false telegram was offered promptly by the Winnipeg Grain Exchange. The sender's identity, however, had not been established at the close of the year. This incident vividly demonstrates the need of an adequate exchange system of censorship of the crop and market information disseminated over the private telegraph wires of futures commission houses.

CHICAGO PUBLIC-WAREHOUSE MIXING OPERATIONS

The administration's survey of the operations of the public grain warehouses in Chicago was continued during the year. Grain in store in these warehouses is deliverable upon Chicago grain futures contracts. Particular attention was devoted to the mixing of different classes and grades of grain stored in these public elevators. The investigation indicated that various grades of grain, covered by warehouse receipts, were used for mixing purposes.

This situation, as well as other questionable practices existing in the public warehouses, was brought to the attention of the business conduct committee of the Chicago Board of Trade, which committee in turn reported the findings of the administration to the board of directors. Conferences between the president of the board of trade and the operators of the public grain warehouses followed. Subsequently, a formal communication was sent to the operator of each public elevator by the business conduct committee of the board of trade, which communication, in part, read as follows:

Your attention is hereby called to the rules and regulations covering warehousing of grain in regular elevators, which make it mandatory that correct records and account of all grain, together with the grades thereof, be furnished the registrar so that a correct record of stocks by grades remaining in store at the end of each week may be reported by him.

Your attention is also called to the fact that our rules and regulations prohibit mixing grain of different grades in any way, shape, manner, or form in warehouses declared regular for delivery of grain under the rules and regulations of the association.

DELIVERIES ON FUTURES CONTRACTS

The volume of trading during the life of each important Chicago wheat, corn, oats, and rye future, the maximum open commitments in each future, the aggregate open commitments at the beginning of the delivery month, the volume of contracts settled by delivery of grain, and the total quantity of actual grain delivered are shown in Table 7.

TABLE 7.—*Volume of trading during the life of certain specified grain futures on the Chicago Board of Trade, maximum open commitments in each future, aggregate open commitments in each future at beginning of delivery month, quantity of each future settled by delivery of grain, and total quantity of actual grain delivered*

[In thousands of bushels; i. e., 000 omitted]

Future	Volume of trading during life of future	Maximum open commitments during life of future	Aggregate open commitments at beginning of delivery month	Quantity of futures contracts settled by delivery	Total quantity grain actually delivered
Wheat:					
1930 July.....	2,747,105	66,173	11,321	5,137	(1)
1930 September.....	2,391,699	69,183	9,257	10,344	(1)
1930 December.....	3,170,739	109,256	22,429	8,600	5,817
1931 March.....	261,617	18,112	5,848	9,356	8,222
1931 May.....	1,561,456	118,031	41,381	2 5,439	5,278
Corn:					
1930 July.....	503,052	26,442	9,874	1,125	(1)
1930 September.....	566,399	19,549	7,822	1,960	(1)
1930 December.....	1,550,381	32,219	10,925	4,207	884
1931 March.....	194,891	8,883	2,666	988	630
1931 May.....	2,021,947	42,487	8,521	2,316	547
Oats:					
1930 July.....	55,550	8,614	1,516	2,858	(1)
1930 September.....	82,203	8,364	1,909	1,763	(1)
1930 December.....	278,458	36,214	5,774	3,043	2,671
1931 March.....	47,243	5,119	1,369	1,033	390
1931 May.....	304,888	35,154	5,163	2,134	464
Rye:					
1930 July.....	121,973	11,551	2,027	3,495	(1)
1930 September.....	88,313	10,801	870	5,056	(1)
1930 December.....	145,242	16,036	6,027	867	790
1931 March.....	22,942	2,658	262	1,247	578
1931 May.....	107,989	13,462	2,190	3,037	295

¹ Quantity of actual grain delivered unknown.

² An unusually large volume of futures contracts also was settled by the exchange of cash wheat for the May wheat future at agreed differentials. This method, in effect, accomplishes delivery without involving technical delivery upon a futures contract.

FALSE TRADING REPORTS; WRONGFUL CLEARING OF TRADES

An investigation initiated by the administration to ascertain the cause of a discrepancy between the long and short side of open commitments reported by clearing members of the Chicago Board of Trade in the 1930 December wheat future culminated in the discovery of falsification of trading records and reports by a minor employee of a prominent Chicago commission house. The employee in question confessed that he, under the name of a fellow employee, a member of the board of trade, had been carrying a futures account with a clearing member of the board. Further investigation disclosed that some of the employee's transactions were cleared by the clearing member in direct violation of board of trade rules.

The disclosures resulted in the appointment by the board of trade of a special investigating committee, and the filing and prosecution of charges against the two members of the firm found to have cleared the irregular transactions, and also against three other members of the board of trade who executed certain of the trades. At the close of the year the following penalties had been imposed by the board: The senior partner of the firm clearing the trades, expulsion from the board; the junior partner of the clearing firm, six months' suspension subsequently reduced by the board to two months; the three brokers who executed certain of the trades, 30 days suspension, 60 days suspension, and 6 months suspension, respectively. The commission-

house employee who falsified trading records, etc., and a fellow employee accomplice were discharged by their employer, and at the close of the year the latter's claim was pending before the board of trade against the membership of the expelled clearing member, and against the clearing house balance of the copartnership in an effort to recover part of the commission house's losses arising from the transactions of its employee.

TRADING IN GRAIN PRIVILEGES

A comprehensive study of trading in wheat and corn privileges ("bids" and "offers," or "puts" and "calls") on the Chicago Board of Trade was continued during the year. The exact volume of trading in bids is unknown, as no record thereof is kept by any organization. More information is available on the volume of trading in offers, in as much as they are subject to a Federal tax. The information compiled to date by the administration indicates that while the aggregate volume of trading in privileges is only about 10 per cent of the total volume of trading in grain futures for the market as a whole, the percentage is considerably greater among the large speculators. It has been found that the use of privileges is confined almost entirely to speculators, and the examination of records covering a 10-month period has disclosed that trading in privileges by 29 large speculators in wheat and an equal number in corn amounted to more than 40 per cent of their combined trading in both wheat and corn futures. The survey, which was in progress at the close of the year, disclosed also that the professional speculators on the board of trade are usually the sellers of privileges, and members of the general public are the buyers.

LITIGATION

An injunction suit filed by Bartlett, Frazier Co., against the Secretary of Agriculture, the administration's grain exchange supervisor at Chicago, the Chicago Board of Trade, and the United States attorney for the northern district of Illinois, was argued before the United States district court for the northern Illinois district on March 18 and 19, 1931. The plaintiff is seeking to restrain the enforcement of certain regulations promulgated by the Secretary of Agriculture pursuant to the grain futures act and requiring clearing members of a contract market to file daily reports showing volume of trading and open commitments, and to enjoin the examination of books and records of members of contract markets. After the trial of the suit the court asked that written briefs be filed by the plaintiff and the Government. No decision had been announced by the court at the close of the year.

A motion to dismiss the complaints filed in 1930 by the Secretary of Agriculture, under the grain futures act, against three members of the Chicago Board of Trade, filed by counsel for the respondents during the last fiscal year, was overruled by the referee representing the commission created by the grain futures act (composed of the Secretary of Agriculture, chairman; Attorney General; and Secretary of Commerce), and these cases were pending at the close of the year just ended. These cases involve two floor brokers who were charged with manipulating the market price of grain by bucketing and taking customers' orders into their own account at prices determined by them to their own advantage and to the disadvantage of the cus-

tomers. A third member is named as having aided in the scheme by loaning his records and office as clearing member in clearing the transactions as if they were genuine trades.

AMENDMENT OF ACT

Bills providing amendments to the grain futures act were introduced in the Congress during the year. At least two of these bills proposed to amend the statute by providing a definite limitation upon the volume of daily speculative purchases or speculative sales permitted an individual trader, as well as upon an individual trader's speculative holdings or speculative commitments. Hearings were held upon one of these measures by the Senate Committee on Agriculture and Forestry during the final session of the last Congress. The proposed legislation was pending in committee upon the adjournment of the Seventy-first Congress.

TRANSFER-OF-SPECULATORS-TO-WINNIPEG MYTH

Recommendations for the betterment of conditions affecting futures-trading operations through the imposition of a reasonable limitation upon the extent of an individual's speculative trading in grain futures so as to facilitate the movement of grain prices in accordance with actual supply and demand conditions, have been received in some quarters with the declaration that prominent American speculators already have chosen to transfer their operations from United States markets to the Winnipeg Grain Exchange, because of the existing governmental supervision of United States grain futures markets. On this point it is of interest to note the finding of the Royal Commission on Trading in Grain Futures, headed by the British economist, Sir Josiah Stamp, which commission investigated futures trading in Canada near the close of the last fiscal year.

The commission, in its report submitted to the Prime Minister of Canada under date of April 29, 1931, declared that no evidence had been adduced before it to support the suggestion that those residents of the United States who recently had been admitted to the Winnipeg exchange had joined the exchange for the purpose of transferring their speculative operations from the United States markets. The Royal Commission found:

In some cases at least these new members had already been trading through the Winnipeg exchange, and membership entitled them to receive the benefit of the preferential rates on commission accorded between members in their dealings on the exchange when acting on behalf of one another. The idea that it might be to escape regulation was inspired merely by inference from the fact that the list contained the name of a well-known speculator. It transpired, during the conversations which we held in Chicago with the individual in question, that his motives in joining the Winnipeg Grain Exchange were solely for the purpose of entitling him to the lower rates referred to.

PUBLICATIONS

Publications issued by the administration during the year included: Trading in Corn Futures (Technical Bulletin No. 199), Wheat Futures, Volume of Trading, Open Commitments, and Prices from January 3, 1921, to December 31, 1929 (Statistical Bulletin No. 31); and Hedging in Grain Futures (Circular No. 151): A statistical bulletin presenting statistical data relating to volume of trading, open commitments and prices of corn futures since January 3, 1921, was completed during the year and is now in press. The manuscript of A Guide Book to Domestic Grain Trade Statistics, was in process of final preparation for release at the close of the year.



REPORT OF THE CHIEF OF THE BUREAU OF HOME ECONOMICS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF HOME ECONOMICS,
Washington, D. C., August 31, 1931.

SIR: I present herewith the report of the Bureau of Home Economics for the fiscal year ended June 30, 1931.

Respectfully,

LOUISE STANLEY, *Chief.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

The work of the Bureau of Home Economics during the past year has been adjusted as far as possible to meet the needs of homes with incomes reduced by the drought and unemployment. This has called for the personal services of the chief and various members of the bureau staff on special committees, has led to the undertaking of new projects, and has given special direction to much of the regular work of the bureau, carried on through its divisions of foods and nutrition, textiles and clothing, and economics. These widening activities have in turn increased the demands upon the administrative and information offices, where the resulting correspondence and requests for advice or service have been partly met by specialized output and specialized distribution of the bureau's publications.

EMERGENCY SERVICES

In the early fall, as a result of the reports from the nutrition workers in the drought States, a nutrition committee was formed as a subcommittee of the emergency drought relief committee. This was made up of representatives of the Extension Service, Red Cross, Public Health Service, Office of Education, and three members of this bureau. As its contribution to the work of the subcommittee this bureau made special studies in low-cost diets, prepared low-cost food guides for use of workers in the drought areas, and issued and distributed many thousands of leaflets.

On account of the fear that the economic situation would be reflected in an increased occurrence of pellagra and other evidences of malnutrition, especially in the drought sections of the South, special attention was given to this aspect of the problem. The results of previous studies on pellagra were summarized, and additional studies were made to increase our knowledge of cheap sources of the "protective foods" as well as those containing the pellagra-preventive factor. This information has been made available from time to time in mimeographed reports and news releases.

In the early winter the woman's division of the President's Emergency Committee on Employment asked that the nutrition service be extended to families with incomes reduced because of unemployment, and to workers with families receiving special aid. The earlier publications were therefore revised, and a series of weekly news releases entitled "The Market Basket" were prepared for the press service, beginning January 9, 1931. It is planned to continue this service, adapting it to meet any special needs that may arise.

Various social agencies have requested information on family budgets. A summary has been made of budgets in use in different sections of the country, and a selected group of these has been mimeographed for distribution. Arrangements have been made for a cooperative study on family budgets to be undertaken with the family committee of the National Conference on Social Work.

WHITE HOUSE CONFERENCE ON CHILD HEALTH AND PROTECTION

During the fall considerable time was given by various members of the staff to the completion of the reports of the White House Conference on Child Health and Protection and to the preparation and presentation of material based on these reports. Members from every division of the bureau, as well as the home economics representatives of the Extension Service, have made a contribution to the final reports of this conference. The reports of the committee on the family and parent education will make up eight volumes of the final report.

PRESIDENT'S CONFERENCE ON HOME BUILDING AND HOME OWNERSHIP

I have been asked to serve as a member of the planning committee of the President's Conference on Home Building and Home Ownership, and am serving on two of the subject-matter subcommittees of this conference. The work of five subcommittees of this conference—home making, household management, kitchens and work spaces, house furnishing, and fundamental equipment—relates very closely to the work of this bureau, and as far as possible the bureau's services are being placed at their disposal. Some of the bureau staff are serving as members of the subcommittee, and Laura C. Brossard, assistant economist in the bureau, is serving as secretary and technical assistant to the conference committee on household management. The amount of factual data on housing and equipment available in form for the use of the home maker is small, and the information collected by this conference should be of great value in bettering conditions of housing and home living. A bibliography on household management has been prepared, and one on kitchens is in preparation. The bibliography on household refrigeration, previously issued, is being brought up to date for the use of the committee on fundamental equipment.

FOODS AND NUTRITION

In the foods and nutrition division the work is continuing under three heads: (1) Food composition, (2) nutrition studies, and (3) food utilization. The work on food utilization has been very much

strengthened by the appointment of Florance B. King, formerly with Iowa State College, in charge of this section.

FOOD COMPOSITION

Studies of the composition of American foods constitute a continuing project of the bureau, the results being published from time to time as they become available. Results of the study of fresh vegetables were published last January. Since then the work has been directed to other classes of foods, and first steps have been taken toward an intensive study that will review and evaluate all the available data on the proximate composition of fresh meats and several types of fruit and vegetable products.

The wide distribution of the food-composition tables already published by the bureau has given rise to an increased demand from persons interested in foods and nutrition for information on the composition of foods not yet reviewed. This has necessitated extending the service performed by the bureau in the past, that of directing workers in related fields to source material.

During the year this section also assisted in the preparation of a manuscript on meals for preschool children, containing data on the chemical composition of cooked foods. This work was done in cooperation with the Merrill-Palmer School in Detroit and is intended for use in nursery schools and other institutions that plan and prepare meals for children between 2 and 6 years of age. Standards of adequacy are presented, together with suitable menus and recipes for preschool children. This is an especially important contribution, because so little accurate information is available on the composition of cooked foods. The cooperation of the food utilization section was had in checking weights, proper time of cooking, and recipes.

Because of the increased emphasis at present on the nutritive value of the mineral constituents of food, numerous requests come to us for this information. A card file of references to mineral content of food is maintained to answer such requests. It is desirable to extend the work of this section to make possible a more complete collection, evaluation, and summary of these data for publication.

NUTRITION STUDIES

The staff of the nutrition section has worked closely with the food economics unit in the analysis of data obtained from dietary studies among various groups of people and has assisted in the preparation of material on food selection to meet special needs, as already described.

A summary of the information on child feeding, resulting from an experiment at the Washington Child Research Center, has been prepared as a Farmers' Bulletin under the title "Food for Children." This includes suggested menus and recipes. A set of 8 charts, presenting some of the same facts, have been published for groups needing illustrative material.

VITAMIN STUDIES

PELLAGRA PREVENTION

Following up the pellagra study already referred to, assays have been made of vitamins B and G of five samples of wheat germ, one

sample of cottonseed flour, and a composite sample of the brand of yeast used in the laboratory. It was found that wheat germ is as rich in vitamin B as yeast and one-half to one-third as rich in vitamin G. The five samples of wheat germ tested were quite uniform in their content of these factors.

In view of the report of the finding of vitamin G in cottonseed meal, it seemed desirable to test cottonseed flour for this vitamin. A commercial product was selected that had been found to be valuable in other ways as human food and had been on the market for more than 10 years. The tests showed that cottonseed flour is slightly less rich in vitamin G than is wheat germ and is a fair source of vitamin B. In the quantities suggested for use in baked products, it would afford ample amounts of the pellagra-preventive factor for most diets.

At the request of the home demonstration agents of one of the Southern States sugar-cane was tested as a possible source of vitamin B or G. It was found to contain neither in detectable amounts.

The study of banana powder was completed and reported. Later tests showed it to be a more valuable source of vitamin G than reported last year. It contained three-fourths as much vitamin G as the equivalent amount of fresh fruit.

The determination of vitamin G in foods has been retarded in many laboratories because of lack of standardization of methods, and the requirement, in the methods suggested, of a vitamin B extract that is difficult to prepare. Because of this, special attention has been given to the development of a satisfactory method using a more easily prepared basal diet. As a result of these studies the bureau recommends that, in cases where conditions do not permit the purchase or preparation of vitamin B extracts free of vitamin G for use in vitamin G assays, white corn to the extent of 30 per cent of the diet may be used to supply an adequate amount of vitamin B with little addition of vitamin G. This diet can be used successfully in tests for vitamin G, providing all comparisons are relative to the growth rate of the controls on the basal diet only. Workers using this basal diet are cautioned that the animals selected for such comparisons should be of one sex, or that each group should contain the same number of males and females. The test is more sensitive when the rate of gain is about 4 to 5 grams a week.

The work on vitamins B and G is being continued in an effort to determine more exactly the physiological effects of vitamin G with the idea of differentiating it from other still unidentified factors. These studies are well under way and should throw additional light on the relation of vitamin G to pellagra.

VITAMIN ASSAYS

The study of the vitamin content of grapes and grape products was completed. Fresh Thompson Seedless (Sultanina) and Malaga grapes were found to be a fair source of vitamins A and B. Thompson seedless grapes contained small amounts of vitamin G, while none was found in the Malaga grapes. Fifteen grams of fresh Thompson seedless grapes contained a sufficient amount of vitamin C to protect guinea pigs against scurvy as determined by the Hojer method. This is approximately the same protection as afforded by

2 cubic centimeters of orange juice. Fifteen grams of Malaga grapes was insufficient to protect them from scurvy.

Two samples of commercial grape juices were studied, one a mixture of juices from Flame Tokay and Zinfandel varieties and the other from Concord. There was no evidence of vitamins A, C, or G in either juice. The juice from the Concord grapes furnished some vitamin B.

The results of this study were reported in a paper read before the medicinal chemistry section of the American Chemical Society in Indianapolis last fall and have been prepared for publication in the *Journal of Agricultural Research*. The study is being continued to include certain eastern varieties in fresh form. In connection with the above studies the Hojer method for testing for vitamin C was studied and standardized for use in this laboratory.

The study of the vitamin A content of olives was completed, and the results are being summarized for publication. Vitamin A was found in relatively large amounts in both ripe and green olives. No appreciable amounts of vitamins B, G, C, or D were found.

A preliminary study was made of a tuber that closely resembled the ordinary potato in texture and appearance but was deep yellow in color. This tuber contained small but appreciable amounts of vitamin A. The study is to be continued when large amounts of material can be supplied.

FOOD UTILIZATION

MEAT STUDIES

The cooperative study on palatability of meat as affected by different production factors and different methods of cutting, handling, or cooking, has been continued. This study was planned jointly with the Bureaus of Animal Industry and Agricultural Economics. The meat was produced at Federal livestock farms and cooperating State experiment stations. During the year 243 ribs of beef, 448 legs of lamb, 233 pork roasts, and 40 pieces of cured pork have been tested for palatability. Progress has been made in summarizing the results of these studies, and during the past year articles or chapters on the subject have been contributed to the *Yearbook of Agriculture*, to a bulletin of the Bureau of Animal Industry, and to two outside periodicals.

A study undertaken to determine the relation between the style of cutting 2-rib beef roasts and the time required for cooking the meat showed that for standing ribs the total cooking time is independent of the length of the rib bones. Cutting off several inches of rib bone makes considerable difference in the weight of the roast, however, and the number of minutes per pound required to cook the roast varies with the length of the bone. It is necessary to allow several more minutes per pound at any given oven temperature to cook short rib roasts than for long-boned roasts.

Boned and rolled 2-rib roasts required more total time to cook than is necessary if the rib bones are not removed. On the basis of the time per pound of boned roast, it is found that these roasts require from 10 to 15 minutes per pound more than the average time required for standing roasts.

Two separate studies have been made, one on beef and one on lamb, to determine the effect of aging on palatability. The results of these have not yet been summarized.

In continuation of the studies on the relation of the fell on lamb to palatability and cooking, four pairs of legs were cooked and judged. The results confirmed earlier work done in the bureau, indicating that lamb requires longer to roast and shrinks more when the fell is removed. Further work on this subject is needed before final recommendation can be made.

Cooking experiments have been carried out with cured pork to determine the method and length of time required to cook whole hams, half hams, skinned hams, and boned hams. These data, together with results from cooking tests on other forms of cured pork, have been used in the preparation of a leaflet on cooking cured pork.

CEREAL PRODUCTS

The bureau has for several years recommended the use of wheat germ and rice polish in communities where the diet is likely to be lacking in vitamins B and G, but the tendency of these products to grow rancid under the usual conditions of storage has limited their use. Studies to find a method the home maker might use to retard rancidity were accordingly continued last year. It was found that bitterness became noticeable before the typical odor of rancidity could be detected, and this bitterness increased as rancidity developed. Color tests for rancidity were found not to be dependable, and other chemical tests were little recommended. Bitterness in flavor was therefore used as a criterion of the development of rancidity.

The most satisfactory home method of preserving wheat germ and rice polish was found to be heating the product 8 to 10 minutes in a $\frac{3}{4}$ -inch layer at 375° F. (190° C.). After heating the material was packed in air-tight containers and kept from the light. This finding agrees with the reports made by a number of investigators, that rancidity is caused by an autocatalyzed oxidation which is independent, or almost independent, of enzyme action.

Because corn meal makes up such a large proportion of the diet in sections of the country where pellagra is most prevalent, studies were made of various possible additions to corn meal that would improve its food value and help to correct its deficiency when it makes up a large proportion of a restricted diet. Formulas were worked out for enriching corn meal with dried skim milk or a combination of dried skim milk and wheat germ or rice polish. This mixture supplied adequate amounts of the pellagra-preventive factor, added other essential elements to the diet, and at the same time yielded a very palatable product.

Comparative cooking tests on eight native-grown varieties of rice have been continued, and it has been shown that these rices required different lengths of time for satisfactory cooking. This lends support to the effort to prevent mixing of varieties in the marketing of rice. A score card has been prepared, and these rices have been ranked in accordance with cooking quality. A popular leaflet on rice cooking also has been prepared, and a technical report of the cooking tests is being edited. The rice samples are being held for study of the influence of aging on quality and cooking behavior.

CANNING

In view of the emphasis on canning during the present year, it was deemed advisable to revise and bring up to date the bulletin on home canning of fruits and vegetables. In connection with this some studies were made on the canning of mushrooms in order that this information could be included in the new edition of the bulletin. In bringing together the data for this bulletin, various canned products which had been stored varying periods of time were checked, and the results were added to the data available in the files of this office. All this material has now been brought together as a circular entitled "Summary of Data on Canning Investigations of the Office and the Bureau of Home Economics, United States Department of Agriculture," which has been submitted for publication.

In connection with a revision of Farmers' Bulletin 1186, Pork on the Farm, Killing, Curing, and Canning, by the Bureau of Animal Industry, we were asked to bring up to date the section on canning. For that purpose 946 containers of pork have been canned, and it has been found that the flavor and the texture of the canned meat was equally good whether the meat was packed raw or precooked either in water or by roasting. In general it was found more convenient to pack if precooked in water. The final recommendations as to temperature and time for containers of different sizes are being postponed until bacterial examination and organoleptic tests can be made of this material after storage for a 9-month period.

Similar studies have been made in canning poultry. The initial studies seem to indicate that, as in the case of pork, previous treatment (packing raw or precooking in water or by roasting) has little influence on the flavor of the final product. Containers have been set aside for later examination.

VEGETABLE COOKERY

The study of quality of potatoes, in cooperation with the Bureaus of Plant Industry and Chemistry and Soils, has been continued, the aim being to determine the effect of breeding, fertilization, and storage upon the cooking quality of potatoes. Using the work of the previous year as a basis, the score card has been revised. No summaries or correlations are as yet available, but a preliminary paper was presented before the Potato Growers' Association at Cleveland last December. The practical results of the potato-cooking experiments are being brought together in a leaflet.

To supplement the recommendations sent out for low-cost diets, studies have been made from time to time of various products that were found to be readily available. Since both Pinto and Great Northern beans were abundant in all the markets, recipes for their use were worked out and distributed in mimeographed form. At the request of the Tariff Commission the bureau was asked to study the difference between characteristics of the California Lima bean and the imported Lima bean. The studies showed these varieties to be quite similar in cooking quality, although the imported bean retained its shape when cooked somewhat better than the native bean.

As an introduction to a series of leaflets on cooking vegetables, a circular bringing together the principles of vegetable cookery has

been prepared and is now in press. A beginning has been made in the study of methods of preparation of mushrooms as a basis for a leaflet on this subject. Several new vegetables have been referred to the bureau by the Bureau of Plant Industry, and special work was done on chayotes and bamboo sprouts. The work on chayotes will be included in the vegetable leaflets now in preparation.

The food-utilization section, as usual, has been called upon for considerable service work. Recipes have been tested for the nutrition section, for the bulletins on child nutrition, and the circular on Mid-day Meals for Preschool Children in Day Nurseries and Nursery Schools, for radio work, for the press releases, and The Market Basket. Special recipes were formulated for use in Federal prisons to increase the use of vegetables in prison dietaries.

HOUSEHOLD REFRIGERATION

In connection with the work of the foods and nutrition division, studies on household refrigeration have been continued. These investigations have included studies of the relative efficiency of various grades of household refrigerators, with special emphasis on the development of test methods. The bureau has assisted in the development of the test code which has been approved by the refrigeration subcommittee of the American Standards Association.

During the last year samples of the newer line of refrigerators were studied to compare them with those studied earlier. In general it may be said that the new boxes are more efficient than the majority of those which were available four years ago, but one of the higher-grade boxes which had been in service over a period of four years was retested and found to yield as good results now as when first tested. These tests will be continued from time to time in order to determine the life and duration of efficiency of boxes of different grades.

A comparative study of the relative efficiency of 50 and 100 pound boxes showed the larger box generally more efficient. The boxes were torn down at the conclusion of the test, and the construction was analyzed to determine how the efficiency of the 50-pound box might be increased.

Some of the older boxes which have been in service in the bureau for some time were torn down to discover the point at which the lining showed moisture leakage and absorption of moisture by the insulation. Pictures and full notes were taken of these as the first step in accumulating data on the maintenance of efficiency and durability of boxes.

Studies have been made of the so-called ice fin, a heavy metal device set into the ice compartment to extend the cooling surface. This device has a solid back with extruded or cast fins extending on one side. It increases ice meltage, lowers the temperature in the box, especially in the milk compartment, and makes it possible to maintain the temperature even when the ice cake is much diminished in size. It gives promise of making lower temperatures available by use of ice, and of reducing the frequency of reicing, which in some cases is difficult.

The bacteriological study of meat held at different temperatures was continued. It was shown that the increase in development of

bacteria in samples of meat increased markedly after 50° F., and it is recommended that meat be kept at the same low temperature recommended for milk, 45° F. or below. Studies of development of bacteria in meat give much more irregular results than in milk because the tendency of bacteria to grow in clumps prevents satisfactory sampling, and also because different types of bacteria predominate at different stages of spoilage. On this account an attempt to find the chemical tests which might be used to measure the degree of spoilage proved unsuccessful. These studies need to be continued with special emphasis on the type of bacteria present. The results so far have been summarized in a popular abstract which appeared in the last Yearbook.

ECONOMIC STUDIES

Work has continued during the year on four types of economic studies: (1) Standards of living, (2) food-consumption trends, (3) family budgets and purchasing problems, and (4) housekeeping-efficiency studies. Toward the close of the year members of the staff cooperated in the preliminary work of several committees of the President's Conference on Home Building and Home Ownership, assembling material and outlining problems on the relation of housing to family income and household management. Cooperation was also given in a second national conference on household employment, called by the National Committee on Employer-Employee Relationships in the Home, of which the chief of the bureau and the head of the division are members. Contacts with several national organizations concerned with standard specifications for consumers' goods were maintained by the head of the section on standards of living.

STANDARDS OF LIVING

The investigation of the standards of living of families on marginal farms in the Appalachian highlands, begun in the spring of 1930, has been continued during the year in cooperation with the Bureau of Agricultural Economics and the agricultural experiment stations of Kentucky and Virginia. The field work in the Kentucky study, which was completed in the summer of 1930, covered 230 mountain families in Knott County. Preliminary reports of the findings of this survey were presented at a conference with the extension service of the University of Kentucky and at a meeting of the Kentucky Home Economics Association. The material is now being prepared for publication. A second survey was begun in June in Grayson County, Va., an Appalachian community of a somewhat different type, in cooperation with the Virginia Agricultural Experiment Station.

These Appalachian studies include detailed information as to the expenditures of the families for food, clothing, recreation, and other items, and as to the food and fuel furnished by the farm or obtained from the mountain side. Information is also secured on the kinds of houses occupied and their furnishings and equipment, and on the extent to which spinning, weaving, food preservation,

and other work are carried on in the home. Sanitary conditions and health are being considered, and measurements are being made of the physical and mental development of the children. This information concerning living conditions will be related to the facts obtained by agricultural economists and other cooperators regarding the size and sources of the family income, the type of soil farmed, the use made of the land, and the character of the schools and other community facilities. An understanding of such relationships is essential to the development of programs for the improvement of standards of living in this area.

The division is also cooperating in the preparation of a graphic summary of all of the data now available on the economic and social problems of the southern Appalachian highlands. This material is being prepared jointly by the Bureau of Agricultural Economics, the Forest Service, the Office of Education of the Department of the Interior, the agricultural experiment stations of several States, and this bureau. It will be the responsibility of this bureau to analyze and present existing information on the standards of living prevailing in different parts of the area, and to indicate as far as possible the major factors affecting the adequacy of these standards.

FOOD CONSUMPTION

Studies of the food consumption of various groups of the population have been continued during the year. A report has been prepared of a study of the food supply of 73 marginal farm families in South Carolina among whom pellagra is prevalent. This report gives information regarding the dietary habits of families successful and unsuccessful in warding off the disease and reports the effect upon pellagra incidence of adding definite amounts of certain pellagra-preventing food materials to the diet. On the basis of these facts suggestions are given for improving the diet through a program of home production and conservation of food. This investigation was made cooperatively by the foods and nutrition and the economics divisions of this bureau and the South Carolina State Extension Service, assisted by the State board of health.

Additional information has been gathered, through careful dietary records, of the food consumption of representative farm families. These data are being analyzed in conjunction with similar material gathered in 1926-27 and in the national dietary survey of 1917-18, to show the nutritive value, adequacy, and economy of the diets of these farm groups and to indicate the changes in food consumption that are taking place. Analysis is also being made of the records of food consumption of other types of families included in the 1917-18 dietary survey. This material, collected by the former Office of Home Economics, but for the most part not yet analyzed and presented, covers a large number of rural and city families, including many in the business and professional group. It will furnish an excellent basis from which to measure trends in food consumption.

As an aid in computing the nutritive value of diets, a circular has been prepared on the iron content of common vegetables and fruits. It includes new data for 80 different varieties, forms, or parts of these plant foods, and also some figures taken from the literature. The chemical analyses were made in the laboratories of the depart-

ment of chemistry of Columbia University, and the manuscript has been submitted for publication in cooperation with that department. It will be of particular value to nutrition workers, dietitians, physicians, and others interested in the amount of iron in various American food materials.

FAMILY BUDGETS AND PURCHASING PROBLEMS

During the year the demand for practical material on family budgets and the purchasing problems of the housewife has been greatly intensified by the economic depression and by the drought, and the staff of the division has given as much time as possible to meeting the many requests that have been received. These requests have come from housewives themselves and from extension workers, welfare agencies, and others engaged in helping families to make the most of their resources. The demand for material on planning and purchasing an adequate diet has been especially great, and several publications on the subject have been issued. At the request of the drought-relief committee, a circular entitled "Buy Health Protection With Your Food Money" was prepared in cooperation with the Extension Service, the Public Health Service, and the American Red Cross. This circular was distributed in mimeographed form by the Extension Service. The material, rearranged and partly revised, was later issued jointly by the Extension Service and this bureau under the title "Adequate Diets for Families With Limited Incomes." The information in this publication has been put in brief popular form in a leaflet issued by the department on The Family's Food at Low Cost, in a publication for teachers issued by the Office of Education, and in a leaflet for housewives on pellagra protection, issued by the Extension Service. In order to reach a still larger group of housewives, a weekly news release entitled "The Market Basket," has been issued by the press service since January, giving practical suggestions on food selection and on current food prices. This new series was started at the request of the woman's division of the President's Emergency Committee for Employment.

At the request of the same agency, a survey was made of the budgets in current use by social agencies, department stores, savings banks, and college departments for city families, and the preparation of a popular bulletin on family budgets was started. A similar survey was made of budgets for farm families, at the request of the White House Conference on Child Health and Protection, and the provisions for children in these budgets were analyzed for a report of this conference. This work on family budgets will be continued during the coming year in cooperation with the National Conference of Social Work, in order to provide practical material for use by welfare agencies engaged in aiding city and rural families.

In cooperation with the extension group in the American Home Economics Association, forms are being devised and tested for a household account book adapted to the needs of farm families. It is hoped that this book will be used by extension workers in many States, thus serving the double purpose of assisting individual housewives in the management of the family finances and of providing comparable information on family expenditures for use by research workers.

A new line of studies has been started during the year on the economical purchasing of low-cost dietaries. Using the suggested dietaries prepared for families of limited incomes, the important food materials are being priced at various types of stores and in various localities, to determine the variations in the price of each food with the quality, variety, form, and quantity bought. From this information detailed suggestions will be prepared indicating the most economical methods of buying the food and the price at which its purchase is justified in view of its comparative nutritive value.

HOUSEKEEPING EFFICIENCY STUDIES

The investigation as to work done in various types of households has been continued. The study of urban households in which the home makers are college graduates has been extended to include records from small towns and to increase the size of the sample from large cities. Tabulations have been made covering the first 400 urban records received, as well as the 929 rural records obtained earlier, on the time spent by the housewives themselves in various kinds of work and leisure, on the help in home making given by members of the family and paid workers, and on the extent to which baking and laundering are done outside the home. These results have been used in the preparation of committee reports for the White House Conference on Child Health and Protection and for the President's Conference on Home Building and Home Ownership. The full reports for both the rural and urban studies will be completed during the coming year.

TEXTILES AND CLOTHING

Early last year the Director of Scientific Work appointed a committee to survey the textile work of the department and to formulate recommendations for its development. In line with those recommendations, increased emphasis has been given to cooperative projects with those bureaus of the department dealing with textile production.

FABRIC COMPOSITION

The studies in fabric composition this year, continuing projects previously undertaken, have dealt with the wearing qualities of household materials manufactured from different grades of cotton, wool, and flax. A study of karakul fur is being planned.

In the cotton studies are utilized sheets manufactured from three different grades of raw cotton. The sheets are in constant use in a Washington (D. C.) hotel, where they are inspected daily by a member of the bureau staff. The first sign of breakage in any sheet made of Good Ordinary cotton occurred after it had been washed 102 times; the first breakage in any sheet of Strict Good Middling cotton appeared after 123 washings, and in those of Middling cotton after 137 washings. The type of break and its location on each sheet are recorded; then the sheet is repaired and returned to service. This study is being carried on in cooperation with the Bureau of Agricultural Economics.

As a part of a larger investigation of the influence of various production factors on the manufacturing properties of wool, the bureau is cooperating with the Bureau of Animal Industry in a study of the relative merits of blankets composed of different kinds of wool produced under the direction of the Bureau of Animal Industry at the United States Sheep Experiment Station at DuBois, Idaho. The blankets are being subjected to actual wearing conditions at the veterans' hospital in Washington, D. C., and a general hospital in Boston, Mass., and laboratory tests are being conducted to measure the properties important to the users of wool fabrics. The textile equipment necessary for the laboratory tests has been installed, and the methods to be used have been perfected during the past year. A study is also being made of the chemical changes taking place in the wool during wear and laundering.

In order to determine the possibilities of investigating the wearing qualities of fabrics containing various grades of flax, a preliminary study is being made of table linen in constant use. This, also, has been possible through the cooperation of a Washington hotel.

Work on karakul fur is being planned in cooperation with the Bureaus of Biological Survey and Animal Industry, as part of a project to determine the economic importance of breeding the karakul sheep in this country. The various physical properties, such as gloss, thickness, and durability, will be studied as an index of the usefulness of the fur.

The temporary change in quarters of the bureau during the year made necessary the installation of a controlled-humidity room for temporary use in connection with the studies of fabric composition, and the experience thus obtained has been capitalized to answer many inquiries from home-economics departments in colleges and universities where controlled-humidity rooms are being contemplated for textile research. An article describing the installation here was prepared and published in a home-economics journal, and a bibliography of references dealing with methods of the physical and chemical testing of textiles is also in preparation for the use of such departments where library facilities are not yet developed in this direction.

TEXTILE MAINTENANCE

IRONING STUDIES

The study of the effect of ironing temperatures and pressures upon the tendering of cotton fabrics has been continued, with experiments directed particularly to the removal of size, measure of the scorching tendency, and chemical damage. A series of experiments has been started in order to develop a reliable method that will completely desize cotton fabrics without tendering the cellulose. In general, it has been found that the methods used to remove the sizing materials most completely also tender the fabrics to the greatest extent. Our preliminary experiments indicate, however, that enzyme preparations can advantageously be used for this purpose. Tensile-strength values were found to be no lower for fabrics thus treated than for those which had been given one washing under controlled conditions.

The degree of scorch is determined by changes in the reflection of light of known wave lengths. With samples ironed at various known temperatures, tests made upon a very good grade of sheeting show a greater scorching tendency during the last part of its period of service even though the thickness has not been appreciably changed. Results also indicate that under the same ironing conditions, a greater scorching occurs on the fabrics that have received only the number of rinsings usual in home laundering than for those more thoroughly rinsed. These points are being studied further. It is planned to study also the influence of certain home-washing procedures upon the tendering of cloth during ironing.

The amount of chemical damage produced by various ironing temperatures and pressures upon a number of materials has been measured by means of viscosity and copper-number determinations. A special modification of Hagglund's method of copper-number determination has been developed in the bureau which has proved particularly satisfactory for estimating damage in unbleached cotton fabrics, on which viscosity measurements can not be made. Some work has been done on the changes occurring in the methylene blue absorption of cotton cellulose tendered by heat. A qualitative method for the rapid detection of very slight degrees of oxidation in cotton textiles has been selected and modified. Photomicrographs of cotton fabrics treated with methylene blue have shown that when a cotton material is ironed at scorching temperatures, the top protruding fibers are oxidized to a surprising degree as compared with the mass of the fabric.

SIZING STUDIES

The evaluation of different types of sizing and finishing mixtures used in the laundering process has been continued along the lines previously set up.

The properties of these starches have been studied and the data incorporated in a technical bulletin entitled "Some Physical Properties of Starch Pastes which Affect Their Stiffening Power on Fabrics," which has been submitted for publication. These results show that the stiffness of a sized fabric depends on the penetrating and coating powers of starch pastes, and these factors in turn depend in a general way on the consistency or viscosity of the pastes. The findings indicate also that the size of the swollen starch granules bears a definite relation to the penetrating and coating powers of the starch pastes. Work in defining and measuring the pliability of a sized fabric is now under way.

A poster showing methods and materials used in removing stains from fabrics was prepared in cooperation with the Office of Co-operative Extension. This chart, which was devised to stress the importance of the proper manipulation of the stain remover, is useful to both school and extension groups. The need for information on this subject is evident from the wide circulation of the Farmers' Bulletin entitled "Stain Removal from Fabrics: Home Methods." This bulletin is being enlarged at the present time to include additional instructions.

TEXTILE UTILIZATION

The work on textile utilization consists of experimental study to determine new and more satisfactory uses for fibers grown in the United States, and through popular publications to demonstrate these uses to the home makers of the country.

HOUSEHOLD TEXTILES

The making of hooked rugs, which has reached considerable proportions as a home industry, has become part of the home economics extension teaching in many States. Therefore, in cooperation with the Bureau of Agricultural Economics, a project was initiated this year for the purpose of developing a new cotton fabric which would be a suitable foundation material for all types of fillers used in hooked-rug making. Burlap has been chiefly used as a foundation, but as a result of this bureau's experimental work a cotton material has been developed which will take all kinds of fillers, is easy to handle in the frame, and easy to work with when stamping the design. It utilizes a short-staple cotton, is more durable, and can be manufactured at a sufficiently low cost to compete with burlap, thus providing another outlet for cotton.

Sample lengths of this new cloth are being sent to extension specialists in the States, who are asked to make further tests of the material, and efforts are being made to interest mills in its production.

A popular leaflet, which is in preparation, will stress the use of cotton foundation materials for hooked rugs, choice of pleasing colors, good patterns, and methods of making designs.

Farmers' Bulletin 1633, entitled "Window Curtaining," issued during the past year, describes and illustrates recommended uses of cotton materials for window draperies. Leaflet 76, Slip Covers, offers suggestions for improving the appearance of worn furniture and at the same time suggests the utilization of cotton.

Another leaflet, entitled "Livable Living Rooms," has been submitted for publication. It is the first of a series of house furnishing leaflets prepared in response to a request from the Office of Cooperative Extension, which is placing particular emphasis at this time on inexpensive home improvement as a means of creating more satisfying home living conditions.

The lantern slide, First Aid in Window Curtaining, which was revised, will soon be ready for distribution again under the title "Aids in Window Curtaining." A lantern-slide set is in preparation to supplement the leaflet on living rooms, and two posters have been prepared for distribution among field workers in extension service, illustrating and supplementing the bulletin on window curtaining and slip covers. Material was supplied to the building and housing division of the Bureau of Standards for exhibit purposes.

CHILDREN'S CLOTHING

The work on children's clothing has been continued. The bureau's effort here is to develop designs that allow maximum activity, comfort, and convenience, ease of adjustment, construction, and laundering, and also, by collaboration with manufacturers, to find and utilize

new cotton and wool materials which are especially suited to children's clothing. Cooperation has been effected with maternity centers, hospitals, nursery schools, child-welfare organizations, and individual mothers, to aid in testing the results of the experimental work in this field.

Three exhibits showing garments constructed according to these designs are now being sent throughout the United States in answer to requests for them. To date they have been loaned to 90 groups, including nursery schools, colleges, universities, extension meetings, medical and nurse associations, parent education groups, and meetings of manufacturers of children's wear, retailers, and sales people. Two manufacturers of notions are using some of the bureau's designs on which to demonstrate the use of their products, and commercial patterns for 13 of the designs originated here have been put on the market by four different pattern manufacturers. At present three manufacturers of ready-to-wear clothing are considering some of the designs for production.

This year new designs for little girls' dresses have been developed, and the results published in a leaflet, while new rompers for creeping babies and toddlers have been devised, and a leaflet describing them is now in press. A revision of the leaflet on winter play suits, which will contain new designs for both play suits and headwear suitable for cold and inclement weather, is almost complete.

A study of infants' wear is now under way. New designs for dresses and slips which will be comfortable and decrease the handling of the young baby during dressing have been developed as a result of consultations with child specialists, nurses, and mothers. The suggested designs will be tested in various institutions and individual homes.

A film strip showing recommended designs for boys' suits, girls' dresses, winter play suits, headwear, sun suits, and rompers for creeping babies is in preparation for distribution by the office of cooperative extension work.

Two members of the bureau staff were members of the subcommittee on children's clothing of the White House Conference on Child Welfare and Development, and bibliographical material and photographs were supplied by the bureau for the use of this committee.

REFERENCE SERVICE

The reference and abstract service of the division has been maintained and, as measured by the requests which have come for reference lists, it is meeting a recognized need in home economics departments. Bibliography No. 6, a selected list of scientific periodicals publishing the results of textile research, intended as a guide to those research institutions interested in building up a textile library, has been prepared in mimeographed form.

BUSINESS OFFICE

A reorganization, under the direction of the head of the business office, has considerably facilitated the business operations of the bureau. Beginning with the last fiscal year the bureau took over its own accounts, which were formerly handled in the office of the Sec-

retary. A representative from the Comptroller General's office assisted in the setting up of an accounting system, which has worked smoothly and has enabled the division chiefs to keep closely in touch with their own expenditures. The bureau files have been centralized under the business office, and plans have been worked out for handling general correspondence under this same unit.

LIBRARY

The efficient management of the library has contributed largely to the work of the specialists of the bureau. The library staff has prepared several lists of references specially needed for correspondence and the research activities of the bureau. Special assistance was given in the checking and editing of a bibliography on the family, prepared as a part of the work of the committee on the family and parent education, of the White House Conference on Child Health and Protection.

INFORMATION SERVICE

The extent to which the research work of the bureau is functioning is forcibly shown by the increasing demands upon the information service. Individuals and groups, home makers, writers, professional workers, and commercial interests swell the volume of correspondence annually. This year the number of letters handled was 37,426, a surprising total in contrast with 20,000 of the preceding year. In addition to sales by the Superintendent of Documents, 2,865,575 copies of our publications were distributed free on request.

As in previous years the material published was prepared to meet both the technical and the popular demand. This year in response to the emergency caused by the drought and unemployment, three special publications on low-cost diets were prepared, two in cooperation with the Extension Service and one with the Extension Service and the American Red Cross. These publications are included in the following 11, which are either printed or in press:

- Proximate Composition of Fresh Vegetables. Circular 146.
- Food for Children. Farmers' Bulletin 1674. (In press.)
- Slip Covers. Leaflet 76.
- Rompers. Leaflet 79. (In press.)
- Dresses for Little Girls. Leaflet 80.
- Cooking Cured Pork. Leaflet 81.
- The Family's Food at Low Cost. (Unnumbered.)
- Emergency Low-Cost Food Supply which will Help Prevent Pellagra. (Unnumbered.)
- Adequate Diets for Families with Limited Incomes. Miscellaneous Publication 113.
- Aunt Sammy's Radio Recipes Revised. (Unnumbered.)
- Child-feeding charts. Series of eight, 16 by 20 inches in size.

The following manuscripts have been submitted for publication:

- Some Physical Properties of Starch Pastes Which Affect Their Stiffening Power on Fabrics. Technical Bulletin.
- The Vitamin A, B, C, and G Content of Thompson Seedless (Sultanina) and Malaga (*Vitis vinifera*) Grapes and Two Brands of Commercial Grape Juice (*V. vinifera* and *V. labrusca*). Article for Journal of Agricultural Research.
- Midday Meals For Groups of Preschool Children in Day Nurseries and Nursery Schools. Circular.

The Iron Content of Vegetables and Fruits. Circular.

Summary of Data from Canning Investigations of the Office and the Bureau of Home Economics, United States Department of Agriculture. Circular.

How to Cook Rice. Leaflet.

Eleven articles were contributed to the 1931 Yearbook of Agriculture, reporting the results of special projects in each of the three divisions of the bureau, as follows:

Child-Welfare Studies Important in Work of Home Economics Bureau.

Clothing Costs Among 1,425 Farm Families Reported in Survey.

Cooking Time Varies With Style in Which Beef Roasts are Cut.

Cottonseed Flour Rich in Vitamin G, Experiments Show.

Fabrics for Children's Play Suits Tested for Resistance to Weather.

Food Composition Tables Revised to Meet Demand for More Adequate Data.

Meat Keeping in Home Refrigerators Studied in Varying Conditions.

Oven Canning Tests Show Factors Governing Heat-Penetration Rates.

Standard Specifications for Household Buying are Being Developed.

Textile Buying for the Home Would be Aided by System of Labeling.

Watermelons Prove Valuable Source of Vitamins A and C.

An unusual amount of effort and time has been given to press material this year in response to the need of the woman's division of the President's Emergency Committee for Employment. A mimeographed release of five pages called *The Market Basket* was sent weekly to 7,631 addresses, mainly newspapers, during the last 25 weeks of the fiscal year. The preparation of this material entailed the development each week of special low-cost recipes in our experimental kitchens. The usual press material, totaling about 300 articles and many special news stories, has been prepared, and in a number of cases special photographs have been made to illustrate articles or for use as separate news pictures. Subject matter and illustrative material have been supplied to magazine and newspaper writers in an increasing measure.

A reference list entitled "*The Homemaker's Own Library*" was prepared by a member of the bureau's staff at the request of Better Homes in America, for publication by that organization. This list brings together books that supplement each other in subject matter, making as a whole a well-rounded reference shelf on problems of the home and of family relationships.

A motion-picture film, *Food Makes a Difference*, was completed on October 24, and five copies were ordered by the bureau for distribution by the office of motion pictures. Since January, when the film was announced for routing, it has been shipped to 46 different addresses in various sections of the United States, where it has been shown to more than 12,000 persons, for the most part at rural meetings.

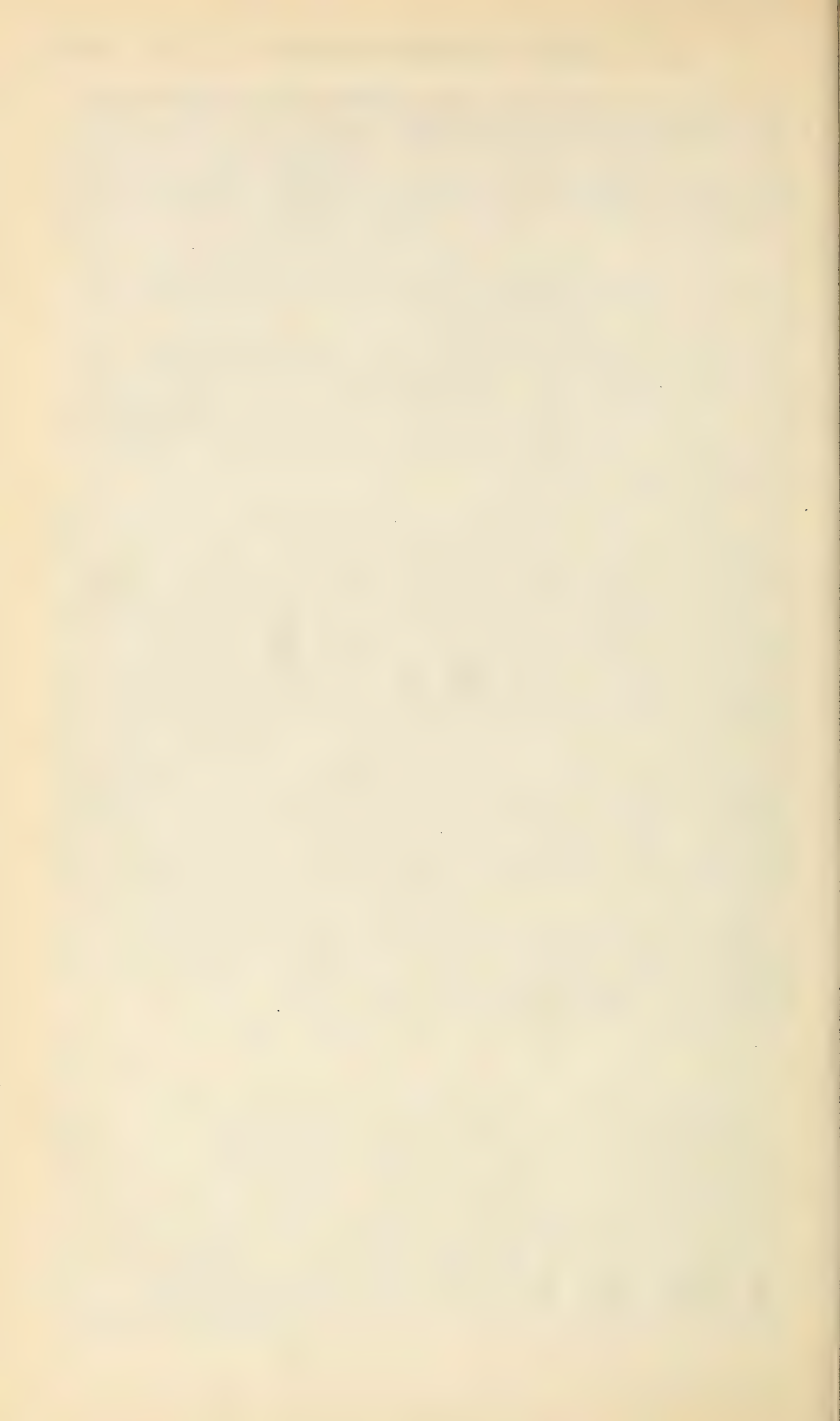
The two types of radio work carried on cooperatively with the department radio service have continued. For the "*Aunt Sammy*" Housekeepers' Chats, mailed out five times a week to 164 stations, 156 menus have been prepared, special recipes developed, the content of programs approved, and in many cases subject matter suggested. As a result of these programs thousands of requests are received from home makers each week for answers to household questions and for recipes and menus. As an aid in answering some of these requests the radio cookbook was revised and enlarged, and published as *Aunt Sammy's Radio Recipes Revised*. In the short time elapsing between the exhausting of the old edition and the printing of the new

one, 8,650 requests accumulated and 13,899 copies of the new cook book were sent the first two weeks after it came off the press.

Forty-five household calendar programs of the bureau were broadcast from Washington as a part of the National Farm and Home Hour over a network of 43 stations. Six special speakers, representing the White House Conference on Child Health and Protection, the National Council for Parental Education, and the American Home Economics Association, were invited to broadcast over this network in October and November, and eight programs in May, presented by special speakers on child development, centered about White House Conference findings.

A number of exhibits for national and international groups were prepared during the year. During August and September two exhibits were placed in the patio of the Administration Building for the Inter-American Conference and the meeting of the agricultural college editors. Special wax models featuring lamb, the center of a balanced meal, were made for the International Livestock Exposition in Chicago in November.

An exhibit with seven features representing work of the bureau was placed in the foyer of a Washington theater for one week in December. Three traveling exhibits of children's garments having special hygienic and self-help features have been sent in response to approximately 90 requests from various parts of the United States. An exhibit of children's play suits was sent to the Netherlands on request for parent education purposes. Three wax-model exhibits of a dinner for a 4-year-old, with equipment to encourage independence in eating habits, have been displayed a number of times. A selection of bulletins and charts went to Egypt as a permanent museum exhibit. Publications and special exhibit material were sent to the annual conference of the American Association of University Women held in Boston, to the National Congress of Parents and Teachers in Hot Springs, Ark., and to the American Home Economics Association in Detroit. Open house was held in our laboratories for the home economics section of the Land Grant College Association, the National Council of Parent Education, and delegates to the White House Conference on Child Health and Protection, all of which met in Washington in November, and for the conference of the National League for Women Voters in April. Special exhibits and open house were arranged for the public of Washington on May 1, child-health day.



REPORT OF THE DIRECTOR OF INFORMATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF INFORMATION,
Washington, D. C., August 31, 1931.

SIR: I present herewith a report on the information work of the department for the fiscal year ended June 30.

M. S. EISENHOWER, *Director of Information.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

SCOPE OF WORK

The information forces of the department during the last fiscal year not only performed the regular work of making available to all groups that can use them, the great variety of data and knowledge developed by the department's research, service, and regulatory programs, but also contributed to the department's efforts to aid the unemployed and the farmers in drought-stricken areas. Many special publications, such as Family Food at Low Cost, New Credit for Farmers, small pamphlets on the prevention of pellagra, special outlook reports, etc., were issued. The press of the country cooperated in disseminating useful information on diets, food at low cost, and availability of funds for seed, feed, fertilizers, and agricultural rehabilitation. By radio many special messages were broadcast, including a number explaining the possibility of communities organizing new agricultural credit corporations and similar organizations, or enlarging the capital stock of existing organizations.

EXPENDITURES

Expenditures for salaries, equipment, and supplies amounted to \$412,989. Of this, more than \$89,000 was for mimeographing, multi-graphing, and rotaprinting work, \$79,500 for mailing lists and distribution, and \$40,000 for business, personnel, filing, and janitorial work. The balance, about \$204,000, was for the preparation and dissemination of agricultural information by the various methods—publications, press, radio, mimeographed leaflets, etc., including the administrative, editorial, and clerical cost of writing, editing, indexing, and illustrating. In view of a rather prevalent misunderstanding, I wish to point out that while the preparation of material for radio broadcasts costs the department about \$30,000 a year, broadcasting facilities themselves cost the department nothing; radio time

is gladly contributed by the radio stations and networks. Nor does the department pay for newspaper and magazine space; the preparation of material for such publication costs about \$44,000 annually.

Printing and binding cost \$942,000. This included the payments for popular and technical bulletins, periodicals, job work, letter-heads, and all other material handled by the Government Printing Office for the Department of Agriculture, with the exception of a few publications and jobs which were, by specific authority of Congress, paid for from other appropriations.

DIVISION OF PUBLICATIONS

The practical contribution to agricultural and home economics education and practice made by the many publications of the department was enhanced during the year as a result of the enlarged printing and binding fund granted by Congress. For many years there has been a steady growth in the basic research, service, extension, and regulatory activities; these activities are naturally producing much socially and economically useful knowledge, which must be quickly and efficiently disseminated. Publications comprise the permanent foundation of the department's informational work.

The number of manuscripts sent to the printer increased from 1,702 last year to 1,737 this year. Included in this number were several emergency publications designed to aid the department's drought and unemployment relief work.

Nearly 32,000,000 copies of the various classes of publications, including over 6,000,000 lists of publications, were distributed during the year. Of this number, 12,446,528 were farmers' bulletins, and 2,058,538 were leaflets. These popularized publications were not, as is frequently charged, foisted upon persons who did not desire the practical information they contain, but were mailed only to those who wrote the department requesting them. As was pointed out last year, the department is able to supply only 60 per cent of the bulletins requested by farmers and others. Indicative of the cooperation existing between this office and the congressional offices is the fact that during the year Members of Congress returned to the department 1,352,577 copies from their allotments of farmers' bulletins.

The technical, semitechnical, periodical, and miscellaneous publications totaled about 17,000,000.

The increase in the number and variety of manuscripts naturally added to the work of the editorial and printing sections. During the last six months of the year, from 75 to 140 manuscripts constituted the daily balance being handled in some stage of consideration, approval, examination, or final preparation. More emphasis than ever before is being placed by the editors upon the organization, style, and brevity of all manuscripts, more particularly in the care of those for popular publications.

Improvement in the presentation of material is dependent first of all upon close cooperation between authors and bureau editors. Consequently conferences of all department editors were held during the year to discuss the types of deficiencies found and how improvements may best be accomplished.

The voluminous analytical index of the department's publications for the period 1901 to 1925 was completed and sent to the printer. The material for this index required 204,142 cards.

The congressional distribution section and the miscellaneous distribution section were merged, and F. J. P. Cleary was placed in charge of the combined unit, designated the distribution section. J. O. Riley, formerly in charge of the miscellaneous distribution section, was assigned to the work of handling requests for agricultural information that require special knowledge or study. The benefits of the merger have been evident in the form of concentration of responsibility for related work, in personnel flexibility making possible adjustments necessary to keep all phases of work as current as possible during the rush periods, and in ease, efficiency, and convenience of administration.

The postage required for sending 308,554 publications to foreign countries during the year amounted to \$5,742.40, an increase of \$132.56 over the amount required the previous year.

The mimeographed, multigraphed, and rotaprinted work done by the division amounted to 61,504,200 pages. The large assembling machine has more than justified its purchase. During the year it assembled 22,950,009 sheets or 36,209,232 pages.

The major personnel changes were as follows: Isabelle Smith, assistant indexer, was transferred to the Bureau of Entomology on February 16, 1931, and Bertha L. Zoeller was appointed March 25, 1931, to fill the vacancy. Amelia Allyn retired August 31, 1930, at 72 years, after 32 years of service in the department, 22 of which were in this division. Norman L. Baldwin, draftsman, resigned July 15, 1930, and Henry G. Stueler was appointed October 1, 1930, to take his place. Corliss Cramer was appointed as a photographer November 10, 1930, to fill the vacancy caused by the death last year of E. F. Shipp. Three temporary employees were appointed for one month each to assist in the work of distribution during part of the rush period in April.

Detailed statistical information covering various phases of the division's work is given herewith in tabular form.

STATISTICS

TABLE 1.—*Summary of manuscripts and requisitions handled July 1, 1930, to June 30, 1931*

Class	Number of requisitions	Number of copies	Class	Number of requisitions	Number of copies
New publications.....	553	13, 445, 633	Posters.....	15	268, 000
Reprints and revisions.....	789	17, 525, 278	Congressional documents.....	20	13, 635
Journal of Agricultural Research separates.....	121	151, 225	Binding.....	285	18, 641
Yearbook separates.....	24	40, 200	Miscellaneous job work.....	2, 952	162, 597, 047
Periodicals.....	219	3, 537, 410	Total.....	4, 978	197, 597, 069

TABLE 2.—*New manuscripts (including revisions of publications requiring new titles and numbers) for department publications handled June 1, 1930, to June 30, 1931*

Item	Manu- scripts on hand July 1, 1930	Received	Disap- proved	Sent to Govern- ment Printing Office	With- drawn	On hand June 30, 1931
Agricultural Situation.....		12		12		
Annual reports and reprints.....		23		23		
Atlas of American Agriculture.....		1				1
Circulars:						
New.....	11	69		55	1	24
Reprints and revisions.....		23		23		
Climatological Data.....		13		13		
Section summary.....		5		5		
Clip Sheet.....		52		52		
Crops and Markets.....		12		12		
Department bulletins, reprints and revisions.....		28		28		
Department circulars, reprints and revisions.....		12		12		
Experiment station bulletins and reports:						
New.....	2	11		11		2
Reprints and revisions.....		1		1		
Experiment Station Record.....	2	19		21		
Extension Service Review.....		12		12		
Farmers' bulletins:						
New.....	14	37		41		10
Reprints and revisions.....		510		510		
Farmers' bulletin lists.....		6		6		
Forest Service recreational folders:						
New.....		36		33		3
Reprints and revisions.....		10		10		
Forest Worker.....		6		6		
Indexes:						
New.....		15		14		1
Reprints and revisions.....		1		1		
Inventory of Seeds and Plants Imported.....		3		3		
Journal of Agricultural Research.....		23		23		
Journal of Agricultural Research separates.....	38	173	25	119	2	65
Leaflets:						
New.....	7	14		14		7
Reprints and revisions.....		52		52		
Miscellaneous circulars, reprints and revisions.....		13		13		
Miscellaneous publications:						
New.....	7	34	1	34		6
Reprints and revisions.....		25		25		
Monthly List of Publications.....		12		12		
Monthly Weather Review.....		13		13		
Monthly Weather Review separates.....		47		47		
North American Fauna.....		1		1		
Official Record.....		52		52		
Posters.....		15		15		
Public Roads.....		16		16		
Secretary circulars, reprints and revisions.....		1		1		
Service and Regulatory Announcements (including Notices of Judgments, Notice of Quarantine, B. A. I. Orders).....		141		141		
Snow and Ice Bulletin.....		18		18		
Soil surveys.....	2	54		56		
Statistical bulletins						
New.....		4		4		
Reprints and revisions.....		1		1		
Technical bulletins:						
New.....	19	60		58		21
Reprints and revisions.....		23		23		
Unnumbered publications and reports:						
New.....		28		28		
Reprints and revisions.....		8		8		
Weekly Weather and Crop Bulletin.....		52		52		
Yearbook.....		1		1		
Yearbook separates.....		24		24		
Total.....	102	1,804	26	1,737	3	140

TABLE 3.—Summary of publications received and distributed by the Department of Agriculture from July 1, 1930, to June 30, 1931

Item	On hand July 1, 1930	New	Reprints	Available for distri- bution	Distrib- uted	On hand June 30, 1931
Agricultural Situation		135, 800		135, 800	135, 800	
Annual reports	19, 670	53, 500	500	73, 670	52, 253	21, 417
Atlas of American Agriculture	5, 148			5, 148	152	4, 996
Circulars	283, 147	616, 800	63, 000	962, 947	535, 579	427, 368
Climatological Data		5, 040		5, 040	5, 040	
Climatological Data (section summary)		4, 800		4, 800	4, 800	
Clip Sheet		322, 200		322, 200	322, 200	
Crops and Markets		1, 760, 000		1, 760, 000	1, 760, 000	
Department bulletins	389, 398		49, 000	438, 398	111, 452	326, 946
Department circulars	223, 398	5, 000	50, 000	278, 398	94, 804	183, 594
Experiment Station bulletins and reports	3, 810	24, 800		28, 610	25, 495	3, 115
Experiment Station Record	14, 712	144, 000		158, 712	140, 512	18, 200
Extension Service Review		125, 073		125, 073	95, 065	30, 008
Farmers' bulletins	8, 412, 759	1, 491, 424	10, 564, 880	20, 469, 063	12, 446, 528	8, 022, 535
Farmers' bulletin lists	1, 494, 450		5, 260, 200	6, 754, 650	5, 925, 900	828, 750
Forest Service recreational folders	87, 900	542, 000	215, 000	844, 900	600, 730	244, 170
Forest Worker		6, 000		6, 000	6, 000	
Indexes	24, 815	56, 048		80, 863	45, 329	35, 534
Inventory of Seeds and Plants Imported		4, 500		4, 500	4, 500	
Journal of Agricultural Research	21, 240	46, 000		67, 240	45, 154	22, 086
Journal of Agricultural Research separates						
Leaflets	224, 910	149, 575	2, 500	376, 985	147, 211	229, 774
Miscellaneous circulars	1, 064, 076	475, 000	1, 785, 000	3, 324, 076	2, 058, 535	1, 265, 541
Miscellaneous publications	315, 939		69, 000	384, 939	138, 484	246, 455
Monthly List of Publications	259, 350	1, 131, 050	472, 500	1, 862, 900	1, 407, 817	455, 083
Monthly Weather Review		412, 000		412, 000	412, 000	
Monthly Weather Review separates		18, 000		18, 000	18, 000	
North American Fauna		14, 200		14, 200	14, 200	
Official Record	2, 921			2, 921	105	2, 816
Posters		886, 000		886, 000	886, 000	
Public Roads	368, 079	130, 500	57, 000	555, 579	172, 161	383, 418
Service and Regulatory Announcements	17, 488	58, 000		75, 488	57, 319	18, 169
Snow and Ice Bulletin	564, 928	708, 000	290, 500	1, 563, 428	953, 609	609, 819
Soil surveys		37, 005		37, 005	37, 005	
Statistical bulletins	156, 819	102, 000		258, 819	46, 724	212, 095
Technical bulletins	39, 753	26, 200	1, 000	66, 953	19, 274	47, 679
Unnumbered publications	234, 073	351, 500	31, 000	616, 573	359, 654	257, 219
Weekly Weather and Crop Report	1, 156, 456	1, 679, 530	152, 200	2, 988, 186	2, 414, 631	573, 555
Yearbook		237, 655		237, 655	237, 655	
Yearbook separates	14, 938	20, 000		34, 938	25, 182	9, 756
	128, 651	56, 300	10, 500	195, 451	62, 238	133, 213
Total	15, 528, 828	11, 835, 800	19, 073, 780	46, 438, 408	31, 825, 097	14, 613, 311

CONGRESSIONAL AND MISCELLANEOUS DISTRIBUTION OF FARMERS' BULLETINS FROM JULY 1, 1930, TO JUNE 30, 1931

On hand July 1, 1930	8, 412, 759
Bulletins issued	12, 056, 304
Total	20, 469, 063
Farmers' bulletins distributed by Congress	7, 683, 425
Schemes for new and revised farmers' bulletins	203, 900
Orders from bureaus in department	712, 075
Extension service orders	1, 911, 760
Miscellaneous distribution	1, 935, 368
	12, 446, 528
On hand June 30, 1931	8, 022, 535
Farmers' bulletins distributed by Congress	7, 683, 425
Leaflets	771, 149
Miscellaneous publications	126, 387
Cookbooks	20, 226
Charged to Congress	8, 601, 187

STATISTICAL RÉSUMÉ OF PRINCIPAL ACTIVITIES IN THE DISTRIBUTION SECTION

Telephone calls received and handled	21, 965
Letters received and handled	867, 655
Orders issued on Superintendent of Documents	598, 677
Letters referred to bureaus and departments	62, 150
Forms addressed and mailed	63, 070
Index cards written	5, 158
Letters dictated and written	3, 253
Letters stamped and returned to Members of Congress	8, 917
Letters received inclosing remittances (\$4,272.80)	14, 432
Visitors received and furnished with 40,824 publications	5, 037
Congressional letters filed	16, 766
Congressional documents filed	43, 379
Orders to send publications to foreign countries	5, 604
Publications sent to foreign countries	308, 554
Money expended in sending publications to foreign countries	\$5, 742. 40
Work sheets furnished to Members of Congress	70, 400
Publications received and stored in stock room	290, 019
Publications issued through the stock room	264, 914

DRAFTING WORK

Drawings	95
Graphs and charts	461
Maps	47
Lettering	485
Retouching	219
Layouts	370
Air brush	22
Cover pages	79
Posters	5
Placards	188
Miscellaneous	129
Engrossing	17
Total	2, 117

PHOTOGRAPHIC WORK

Photographic prints	86, 716
Negatives	15, 655
Negatives developed	1, 792
Rotaprint plates	1, 061
Lantern slides	9, 341
Lantern slides bound	5, 393
Lantern slides colored	686
Enlargements	2, 529
Enlargements mounted	3, 203
Enlargements colored	322
Solar bromides	1, 126
Prints dry mounted	4, 608
Transparencies	67
Transparencies colored	40
Photostats	15, 215
Total	147, 754

Photographers in the section made 376 field trips.

Reimbursements from bureaus for material	\$8, 712. 27
Number of—	
Prints sold to public	893
Bromide enlargements sold	6
Lantern slides sold	8
Photostats sold	26
Reimbursement from sales	\$117. 57

MIMEOGRAPHED AND MULTIGRAPHED WORK

Segments of type set for multigraphing-----	9,399
Stencils cut-----	13,576
Multigraphed pages-----	22,945,157
Mimeographed pages-----	35,083,333
Rotaprinted pages-----	3,475,710
Total pages-----	61,504,200

PRESS SERVICE

The press service, like the other divisions of the Office of Information, has been in its new quarters in the Administration Building for a little more than a year, in which time the advantages of the better accommodations for representatives of the press have been well demonstrated. The room set aside for representatives of the press has proved a great convenience to correspondents and has been a factor in increasing the direct attention the press has devoted to the department. As a result of these better and more frequent direct contacts with a part of the press, telephone requests from Washington correspondents and other writers have also increased greatly, and more writers have asked help of the press service in getting special articles from individual scientists and administrators throughout the department. The National Press Club recently asked to have the number of each of our daily releases delivered there increased from 10 copies to 30.

AGRICULTURAL INFORMATION NOT "PROPAGANDA"

During the last fiscal year several magazine writers and editors have shown a critical interest in the press service; they have published widely their belief that agricultural information is essentially propaganda and "ballyhoo" to increase the prestige of the department. In view of this mistaken idea, it seems well to point out again that agricultural information work is not carried on to secure publicity for the department, but to make public the results of the department's manifold activities and to give the widest possible distribution to valuable facts. The department is, fundamentally, a great educational institution, and the knowledge it develops must be widely and quickly disseminated if it is to make its full contribution to the social and economic progress of the country. Adult education was all but neglected until recent years. To-day no other institutions or group of institutions anywhere play so vital and effective a rôle in adult education as do the State agricultural colleges and the United States Department of Agriculture. From the very beginning, Congress has placed the dissemination of knowledge on a par with the acquisition of knowledge as functions of the department. Only to the extent that the useful information developed by agricultural scientists is given to those who can apply it is the institution justified. In agriculture there was never a time when need for adult education was so imperative as it is now. We may suffer some slight delay in teaching better breeding practices, or improved fertilizer practices, but if economic information is to be of any value at all, it must have an almost instantaneous and wide-

spread distribution. Consequently, with the very willing cooperation of most of the newspaper editors in the country, the department plans to increase its agricultural-information efforts.

COOPERATION OF THE PRESS

Most branches of the press have been suffering heavy cuts in advertising, and as a result many publications have much less space than in normal time; but, in so far as we are able to judge, releases from the department have been used about as widely as formerly. Our daily mail indicates an increase in requests from editors to be supplied with our various services. Most of these applications are, of course, from daily and weekly newspapers. There were more requests than ever before from syndicates for series of articles or for material to be used in preparation of features. For example, the Newspaper Enterprise Association ran two special series on vegetable gardening and flower gardening, and the Central Press is now running a weekly feature which goes to about 500 papers. The Western Newspaper Union, which serves 2,900 weeklies and semi-weeklies, continues to be one of the largest users of practical articles on agriculture and home economics.

The Associated Press, which had been using a weekly wire article on grain markets and one on the livestock situation, recently made arrangements for a similar weekly article on cotton. These articles are prepared by a member of the Washington staff of the Associated Press and are well received by the member papers.

The Market Basket, a weekly article on food at low cost, prepared by the Bureau of Home Economics, has done very well in the newspapers and is often quoted elsewhere. One factor in its widespread use is our new mailing list containing names of 500 editors of household pages.

NEWS PHOTOGRAPHS

The demand for photographs illustrating department activities has been growing steadily for several years and during the last year we have been able to give this branch of work more systematic attention. The result has been a much wider use of news photographs and photographs for illustrating department articles, and those written by outsiders. The availability of interesting pictures based on current activities has, no doubt, made much of our information more appealing to the editors and to the public. One man devoted about half his time to making arrangements for taking pictures and to filling the picture needs of the press from our files and from those of the various bureaus. About 360 negatives were added to our files in the year and about 2,000 prints were made. The press service also used 400 prints of photographs made in various States by the Extension Service, 200 from field offices and experiment stations of the department, and 400 from the photograph files of the bureaus in Washington. This makes a total of about 3,000 pictures used.

A large proportion of the photographs are sent out on request, but a display rack for new pictures has stimulated the interest of free-lance writers, correspondents, and photographers. Our pictures frequently have been used by syndicates, resulting in wide reproduction throughout the country at an extremely low cost to the department.

STATISTICAL SUMMARY

A total of 1,254 mimeographed releases, including 235 bulletin reviews, was issued during the fiscal year. The total was slightly greater than for 1930, partly because of releases on drought conditions, drought relief, and the weekly Market Basket series. There were 113 special releases, not mimeographed. These figures do not include the many home economics articles, most of them illustrated, that were supplied to a group of magazines and newspapers.

PERSONNEL CHANGES

Robert L. Webster was appointed to the position of agricultural writer on May 18, 1931, to fill the vacancy caused by the transfer of John R. Deatherage from the press service to the office of personnel and business administration.

RADIO SERVICE

Important changes and advances in the work of the radio service during the year were as follows:

A new network program, originating in San Francisco and broadcast in the Pacific and intermountain regions by eight stations associated with the National Broadcasting Co., was started on January 1, 1931.

The series of network broadcasts by the chiefs of the eastern and western districts of the Food and Drug Administration was successfully concluded. This series of 52 weekly programs brought widespread attention from the radio audience and launched the "read the label" idea with the general public.

A radio extension specialist was assigned to the Extension Service. Through him the radio service and the office of Cooperative Extension Work have commenced an effort to establish a Federal-State program of broadcasting to farmers and home makers, this program to be carried by 250 cooperating radio stations which serve virtually all parts of the country.

Studies were conducted to determine farmer preferences in style of presenting agricultural information by radio.

These new developments, of course, were in addition to the continuation of the work previously carried on by the radio service.

WESTERN NETWORK PROGRAM

The new network program in the Pacific and Intermountain States is known as the Western Farm and Home Hour. Its schedule is 12.15 to 1 p. m., Pacific standard time, daily except Saturday and Sunday. Ralph H. Lamb was appointed manager of the program. He presides over the programs, schedules speakers from among the department personnel in San Francisco and near by, prepares and delivers four weekly programs from information contributed by the extension services of seven Western States, and handles all other regular activities in connection with the new project. In the programs emphasis is laid on interpretation of the factors making the markets for western products, conservation of the region's resources, detailed weather reports, and the service

work of the department in various fields. Recommendations of improved farming and home-making practices come largely from the State extension services of the region. The response from listeners has increased rapidly. For the first six months of the program it totaled 2,560 letters.

"READ THE LABEL" BROADCASTS

W. R. M. Wharton, chief of the eastern district of the Food and Drug Administration, during the year concluded his series of 52 weekly talks under the general title, "Safeguarding Your Food and Drug Supply." These talks, first scheduled on a network of 13 eastern and midwestern National Broadcasting Co. associate stations, were carried by a network of 32 stations before the close of the series. They brought letters from 25,871 listeners who requested more than a million copies of "read the label" excerpts from the talks.

W. W. Vincent, chief of the western district of the Food and Drug Administration, consolidated his Safeguarding Your Food and Drug Supply series with the Western Farm and Home Hour program when the latter was started, thus increasing his network from three to eight western stations. Listener response to his talks also was exceptional, totaling 5,643 letters, to the writers of which went more than 200,000 "read the label" excerpts.

This series probably will be resumed when the pending bulletin on how to read the label is ready for distribution, providing a printed publication for the further information of listeners interested by the talks.

CORRELATING FEDERAL AND STATE BROADCASTING

The effort to correlate Federal and State broadcasting of information for farmers and home makers was barely started at the end of the fiscal year. In outline, the plan involves decentralization of broadcasting for purely extension purposes. Broadcasting is not a complete educational method. It is unsurpassed as a means of bringing listeners into the circle of influence of extension. But the listener's attention, if we are to make fruitful the interest inspired by broadcasts, must be directed not only to the department, but also to the State extension service which can give him further assistance toward the knowledge he requires in order to adopt on his farm or in his home the practices advocated by the extension service. Therefore, the department proposes to share with the State extension services responsibility for extension broadcasting in cooperation with some 250 radio stations. The program in each State should be developed by the State extension service, written partly by the extension service and partly by the department, and delivered by the county agent or the home-demonstration agent located in the city in which the cooperating radio station is situated.

Alan Dailey, formerly agricultural writer in the radio service, was appointed radio extension specialist March 1, 1931. He started in April upon an itinerary that will take him into every State for the purpose of helping to set up a correlated Federal-State system of extension broadcasting. The system is to be based upon the present Federal and State cooperation with radio stations within each State in broadcasting information to farmers and home makers. Three

States, Arizona, Massachusetts, and New York, had adopted modified versions of the proposed arrangement at the close of the fiscal year. These were in operation. Some 14 other State extension services planned to start the correlated broadcast program by January 1, and some 20 States remained to be visited by the radio extension specialist. The showing is distinctly encouraging in view of the fact that not many extension services have the funds to hire editorial personnel necessary to operate their part of such a service.

WHAT DOES THE FARM AUDIENCE WANT?

A small-scale experiment conducted in cooperation with station WGY at Schenectady, N. Y., during February and March was designed to investigate the various technics that might be employed in the presentation of agricultural subject matter. The standard "farm flash" method of the department releases was checked against eight other methods of presentation. The common-sense judgment from the responses of 38 cooperating farmers—the number was too small to be statistically significant—was that farmers want their information straight, without much sugar-coating.

LAND-GRANT COLLEGE COOPERATION

The chief of the radio service has met with the radio committee of the American Association of Land-Grant Colleges and Universities at each of its sessions during the last two years. He joined with the Director of Information and the Director of Extension Work in proposing to the association late in 1930 an extensive survey of the land-grant college broadcasting situation in order to mark out the wisest line of future development in broadcasting by these institutions and the department. The proposal was accepted by the association, and the chief of the radio service was asked to serve on the organizing committee for the survey.

While the radio-service work expanded during the year, as has been described, the former activities of the organization were maintained—and without increase in personnel. In fact, the writing personnel was lessened by the appointment of Mr. Dailey as radio extension specialist, for his place as a radio service writer was not filled.

NATIONAL FARM AND HOME HOUR

The department's pioneer network program in cooperation with the National Broadcasting Co. continued to expand during the year, increasing from 39 to 44 associate National Broadcasting Co. stations. The time of the program was lengthened from 45 minutes to 1 hour, and the schedule fixed at 12.30 to 1.30 p. m., eastern standard time. In all, 259 members of the department staff took part in the "National Farm and Home Hour" broadcasts. The emphasis continued heavily upon economic analysis, and upon the news of the special relief work and emergency recommendations that followed in the train of the drought of 1930. The "National Farm and Home Hour" continued to be an effective means of sending "rush" information to rural people throughout the country east of the Rockies, and of making vivid and understandable the department's recommendations of farming practices.

Development of the special monthly farm-and-home-hour programs proceeded during the year. The monthly 4-H club program, presented on the first Saturday of each month, was strengthened by the addition of a monthly music-achievement test period, played by the United States Marine Band and announced by Ray Turner of the Federal extension staff. With the approval of the Land-Grant College Association, plans were laid to transform the monthly land-grant college program into a specifically extension program with adequate attention to research in agriculture and home economics. The first program of the new series was broadcast after the close of the fiscal year under review.

SYNDICATE PROGRAMS

In 1930, for the first time in the history of the Radio Service, the syndicate programs were carried throughout the summer. Cooperating radio stations were much pleased with this change of policy. Radio now is a year-round communication medium.

The total number of stations assigned syndicate services on June 30, 1931, was 234. Of these, 171 were broadcasting the daily "Housekeepers' Chat;" 136, the daily "Farm Flashes;" 105, the three-times-a-week "Farm Reporter" at Washington; 115, the weekly "Uncle Sam at Your Service;" 99, the weekly "Primer for Town Farmers;" 86, the biweekly "With Uncle Sam's Naturalists;" 121, the biweekly "Chats with the Weather man;" 115, the weekly "Farm Science Snapshots;" and 121, the monthly "Agricultural Situation Review."

Despite the fact that the radio cookbook was out of print for nearly half the year, the mail from listeners to the syndicate programs showed a great growth. During the year letters handled in the office of the radio service alone in response to syndicate programs numbered 103,892, while letters in response to network programs totaled 47,174. Fully 725,000 came direct to the department mail room, not being referred to the radio service.

FURTHER ORGANIZATION WORK NECESSARY

It becomes apparent that we need closer contact with cooperating radio stations than can be maintained by correspondence from Washington. The first trip of the radio extension specialist (not yet completed) has so far revealed a few instances of sponsorship of department syndicate programs, which have been immediately corrected. The extension specialist has also found a disposition on the part of some station managers to put department programs into the less desirable hours of the broadcasting day. This situation can be corrected only by having a local check on delivery of the programs, such as is involved in the county-agent-cooperation angle of the plan for correlation.

On the subject-matter side, there are two reorganizations needed and they are partly in progress. One is involved in the correlation plan, whereby the States will contribute much valuable subject matter not available anywhere in the department. The other is reorganization in order to codify and make more easily available the information from the bureaus and offices of the department itself. Nowhere is there an index of department publications giving the

regional application and the timely value of information contained in these publications. We have found it desirable to make such an index ourselves. A blank is being prepared to be submitted to division leaders for their use in classifying publications of their divisions for our purposes.

These two things—organization for better relations with the radio stations, and organization for better distribution of applicable, timely subject matter in the releases and the network programs—are prime essentials to progress in agricultural education by radio. A third is research into effective methods of presenting agricultural and home-economics subject matter to the radio audience.

PERSONNEL CHANGES

Dana D. Reynolds was appointed agricultural writer on November 3, 1930, to fill the vacancy caused by the transfer of Solon R. Barber to the Food and Drug Administration. On December 3, 1930, Helen B. Crouch was appointed to prepare the radio housekeepers' programs formerly written by Josephine Hemphill, who resigned on October 18, 1930, to enter commercial radio work. Helen Behringer, secretary to the chief of the radio service, died on May 8, 1931.

BUREAU INFORMATION WORK

All information, of course, originates in the several bureaus of the department. Some of the bureaus give information direct to the public without clearing it through the Office of Information. Weather reports and market news reports are examples of this type of information. In my annual reports for 1929 and 1930 I gave in detail the informational activities of the bureaus. There have been no conspicuous changes in the arrangement explained in those two reports.



REPORT OF THE LIBRARIAN

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE LIBRARIAN,
Washington, D. C., September 1, 1931.

SIR: I have the honor to submit herewith the report of the library for the fiscal year ended June 30, 1931.

Respectfully,

CLARIBEL R. BARNETT,
Librarian.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The tables which are compiled from reports submitted by the heads of the divisions of the main library and the reports of branch libraries in the various bureaus, show in detail the work of the library in so far as this can be presented in statistical terms. A brief summary of the more important statistics is given below:

Volumes in the library on June 30, 1931.....	225, 819
Books, pamphlets, and maps added during the year.....	16, 406
Periodicals currently received.....	4, 183
Dailies currently received.....	90
Separate works catalogued.....	16, 920
Cards added to catalogue (net increase).....	19, 055
Volumes sent to the bindery.....	4, 957
Volumes put in binders.....	3, 072
Volumes circulated.....	68, 465
Current periodicals circulated.....	210, 118

Total library appropriation (including \$20,000 printing and binding allotment).....	\$124, 560. 00
--	----------------

Expenditures:	
Books, periodicals, and newspapers.....	¹ 29, 250. 00
Salaries.....	71, 665. 06
Office supplies.....	651. 73
Equipment.....	898. 32
Repairs and alterations.....	228. 64
Express, freight, and drayage.....	112. 73
Travel.....	78. 87
Printing and binding.....	19, 944. 70

¹ Approximate figures.

Among the more important and valuable old books acquired were the following:

Bolton, James: A history of fungusses growing about Halifax [England]. 1788-91; Cato, Marcus Porcius, Censorius. De agricoltvra. 1598; The country-mans recreation 1640; Eezichung gebrauch. Lernung. Artzney in zufelligen vñ natürlichen krankheitten. 1531; Eliot, Jared. Essays upon field-husbandry in New England, as it is or may be ordered. 1760; Gallo, Agostino. Le tredici giornate della vera agricoltvra. 1566; Larréatgui, J. D. Description botanique du chiranthodendron. 1805; Plantzbüchlin der lustgärten 1546; Reichenbach,

H. G. L. *Magazin der aesthetischen botanik*. 1822-24; Ruusscher, Melchior de. *Natuerlyke historie van de couchenille*. 1729; Schwänder, J. G. *Der vermehrte und viel verbesserte sorgfaltige haushalter*. 1678; Smith, John. *England's improvement reviv'd*. 1670; Vallet, Pierre. *Le iardin dy roy tres chrestien Loys XIII*. 1624.

Among the notable recent books purchased mention should be made of the following:

Bouloumoy, L. *Flore du Liban et de la Syrie*. 1930; British Museum. *General catalogue of printed books*, vol. 1, 1931; Connett, E. V. *Upland game bird shooting in America*. 1930; Galløe, Olaf. *Natural history of the Danish lichens*. Pt. 1-3, 1927-1930; Italy. *Istituto centrale di statistica. Atlante statistico italiano*, vol. 1, 1929; Lönnberg, Einar. *Svenska fåglar efter naturen och på sten ritade*. 1924-1929; Oort, E. D. van. *Ornithologia neerlandica*, vol. 4, 1930; Schjøler, E. L. *Danmarks fugle*, vol. 3, 1931.

In addition to the valuable printed books received, the library also acquired two valuable manuscript works, the *Farm Record Book* of B. T. Tayloe of Virginia, written from 1831 to 1849, and James Bolton's *Icones Fungorum Circa Halifax Sponte Nascentium*, 1784-92. The latter contains a brief handwritten description of each fungus accompanied by a hand-colored plate. Photostat copies were also obtained of two rare and valuable works, namely, William Jameson. *Synopsis Plantarum Aequatoriensium*, 1865, vol. 3, and Hipólito Ruiz Lopez, *Flora Peruviana et Chilensis*. The former was copied from the original in the British Museum and the latter from the original in the Gray Herbarium.

As compared with those for the previous year, the statistics show a slight increase in the number of books, pamphlets, and maps received. Grateful appreciation should be expressed here to all who have generously contributed publications to the library, including the many institutions, societies, officials, and publishers in this country and abroad who have carried the address of the Department of Agriculture on their mailing lists. It is regretted that space does not permit the inclusion of a detailed list of donors to whom the library has been indebted during the past year.

The number of different periodicals received during the year showed an increase of 103 over the number received during the previous year. New cards for the entry of current periodicals were installed and have reduced the time required for entering by nearly one-third, thus releasing the time of the assistant for other work. During the year much time was spent in preparing the list of entries from the library to be included in the Supplement to the Union List of Serials and the List of Serial Publications of Foreign Governments.

The number of books catalogued by the catalogue division was approximately the same as last year, but the uncatalogued publications were nearly 1,000 more, due to the loss during the year of two of the library's experienced cataloguers. The number of titles prepared for printing by the Library of Congress was slightly smaller than last year's. On account of the crowded condition of the catalogue it was necessary during the year to expand it by 60 drawers and to shift the cards from the beginning of the catalogue to the end. The catalogue now contains approximately 700,000 cards. Detailed statistics in regard to the cataloguing are given in Tables 1-6.

During the year book labels were marked with a typewriter using large type, instead of by hand, in ink. The change was made because

of frequent changes in the messenger personnel available for the work, and has resulted in greater uniformity in the labeling.

The statistics of the main library and the bureau libraries show an increase of 5,482 in the book circulation and an increase of 5,067 in the circulation of current periodicals. The interlibrary loans from other libraries were 4,662 as compared with 4,903 last year, and the loans to other libraries outside of the city were 2,481 as compared with 2,544 last year. In addition to the 2,481 books and periodicals lent to libraries outside of the city, 79 photostat copies and 11 typed copies of articles were supplied, making a total of 2,571 loans for the year. This is a decrease of 137 as compared with the similar total of last year.

An exhibit of the library's work was shown in the patio of the Administration Building from September 10 to September 21 in connection with the department's exhibit for the Inter-American Conference on Agriculture, Forestry, and Animal Industry.

Preparatory to the moving of the library to its new quarters within a few months, an exact count was made in May of the number of book shelves occupied in the main library. This count, arranged by classes, is as follows:

	Shelves
Encyclopedias, dictionaries, directories, atlases, etc.....	216
General books, including biography, travel, history, and miscellaneous....	100
Agriculture.....	2, 659
Forestry.....	81
Government documents, statistics, law, and education.....	880
Economics and commerce.....	276
Engineering and manufactures.....	506
Home economics.....	16
Mathematics and the physical sciences.....	769
Biological sciences (excepting botany).....	550
Medicine and hygiene.....	379
Botany.....	451
General scientific periodicals and proceedings of learned societies.....	599
Total.....	7, 482
Special collections, including reserve set of department publications, implement catalogues, horticultural catalogues, farm bureau publications, reprints, pamphlets, Japanese collection, Chinese collection, rare books, folios.....	1, 607
Grand total.....	9, 089

Counting 20 books to a shelf, the figures given above would indicate that approximately 180,000 books are now filed in the main library. The remainder are filed in the branch libraries in the bureaus and offices. In the case of forestry, statistics, economics, commerce, law, engineering, home economics, chemistry, and entomology, the bulk of the collection on each of these subjects is filed in the bureau particularly concerned with the subject.

BIBLIOGRAPHICAL WORK

One addition was made during the year to the mimeographed series, Bibliographical Contributions, of the library, namely, No. 21, entitled "A Catalogue of the Books, Bulletins, and Pamphlets on Apiculture Contained in the Library of the United States Department of Agriculture." The compilation was completed in the fiscal year 1930, but it was not mimeographed until November.

In the Bureau of Agricultural Economics library the following additions were made to the mimeographed series, Agricultural Economics Bibliographies:

- No. 31. California. An index to the State sources of agricultural statistics. Part II. Crops other than fruits, vegetables and nuts; Part III. Livestock and livestock products; Part IV. Land, farm property, irrigation, and miscellaneous items. Compiled by Louise O. Bercaw.
- No. 32. Rural standards of living; a selected bibliography. Compiled by Louise O. Bercaw. 124 p.
- No. 33. Wheat: Cost of production, 1923-1930; references relating to the United States and some foreign countries. Compiled by Louise O. Bercaw.

The typewritten bibliography entitled "State and Federal Publications Dealing with the Marketing of Agricultural Products," which was mentioned in last year's report has been revised and issued in mimeographed form in the unnumbered series.

On account of the demand for Agricultural Economics Bibliography No. 32, Rural Standards of Living, and the fact that the supply was practically exhausted within a few months after it was issued, it was decided to reissue it in printed form as Miscellaneous Publication No. 116 of the department. Another bibliography completed during the year and prepared for printing was the following: Influence of Weather on Crops, compiled by Mrs. A. M. Hannay, of the Bureau of Agricultural Economics library. This is No. 118 of the department series of Miscellaneous Publications and was issued in July, 1931.

In the Bureau of Dairy Industry library, the Dairy Library List No. 2 was revised during the year, and two new lists in this series were issued, namely, Dairy Library List No. 3, Publications Relating to Ice Cream, and Dairy Library List No. 4, Partial List of Periodicals Relating to the Dairy Industry.

The fourth index to the Literature of American Economic Entomology, covering the years 1925-1929, which was prepared by the librarian of the Bureau of Entomology and issued in the series printed by the Association of American Economic Entomologists, was received in book form in February, 1931.

In the Forest Service library the Complete List of Forest Service Publications was brought up to January 1, 1931.

In the Bureau of Public Roads library the bibliography entitled "Partial List of References on Roadside Development," containing 57 pages, was completed and multigraphed in August, 1930. Prior to the meeting of the International Road Congress, held in Washington in October, the following lists were made, the entries being arranged by countries: List of foreign publications in the United States Bureau of Public Roads library (81 p., typewritten); list of foreign magazines received in the United States Bureau of Public Roads library (8 p., typewritten).

In addition to the bibliographies mentioned, numerous brief bibliographical lists in typewritten form have been prepared in several of the bureau libraries, and work was continued on several extensive bibliographies which will probably be completed during the coming year.

The following current literature lists, in mimeographed form, were also continued during the year: Agricultural Economics Literature, prepared in the Bureau of Agricultural Economics library; Agronomy Current Literature and Botany Current Literature, prepared in the Bureau of Plant Industry library; Forestry Current Literature, pre-

pared in the Forest Service library; Highways and Agricultural Engineering Current Literature, prepared in the Bureau of Public Roads library. A new series entitled "Cotton Literature: Selected References," compiled by the librarian of the division of cotton marketing of the Bureau of Agricultural Economics, was begun in January, 1931.

LEGISLATIVE REFERENCE WORK

During the past few years legislative reference work has been one of the important activities of the Bureau of Agricultural Economics library and the Bureau of Public Roads library, as they have been given the responsibility for keeping their respective bureaus informed on new legislation of interest to them. In the Bureau of Agricultural Economics library the progress of 601 bills and resolutions was followed through the last session of Congress and in the library of the Bureau of Public Roads the progress of 730 bills of interest to the bureau was followed. As roads have a large part in the unemployment relief program, 134 of the latter bills became laws, or about a third of the public laws passed during the Seventy-first Congress.

BUREAU AND DIVISION LIBRARIES

A list of the branch libraries in the various bureaus and offices and data in regard to them will be found in Table 13. Cataloguing statistics are included in Tables 5 and 6. Statistics of circulation are given in Table 9. Other activities, such as bibliographical work and legislative reference work, are described in the body of the report under these headings.

One of the new developments during the year was the change in status of the library of the division of cotton marketing of the Bureau of Agricultural Economics, mentioned in last year's report. In January, 1931, the administrative office of the bureau decided to centralize this work and make it a branch of the Bureau of Agricultural Economics library under the supervision of the librarian of the bureau. One of the first duties of the library was the preparation of a daily news sheet entitled "Cotton News Summary," made up of items of interest selected from the newspapers and periodicals received by the division. The compilation of the more permanent literature pertaining to cotton was next undertaken. Beginning with January, 1931, this has been issued monthly under the title "Cotton Literature: Selected References." It is a cooperative undertaking under the auspices of the department library with the cooperation of the Bureaus of Agricultural Economics, Plant Industry, and Entomology. The library staffs of these bureaus furnish references each month from the periodicals relating to their fields.

The foreign files of the Bureau of Agricultural Economics have for some years been jointly administered by the library of the bureau and the division of statistical and historical research. When the foreign agricultural service of the bureau was created on July 1, 1930, the foreign files with the assistant in charge were transferred to that office, in accordance with the recommendation of the librarian of the bureau.

Changes in location were the most important changes in the bureau libraries during the year. The Bureau of Home Economics library

was moved in July, 1930, when the bureau was moved to its new location at Thirteenth and E Streets NW. The Bureau of Entomology, with its library, was moved during the first two weeks of August from the old building in the grounds of the department to the second floor of wing 3 of temporary building C, at Seventh and B Streets SW., it having been decided to tear down the old building. It was regretted that it was necessary to place the library in a building where the fire hazards are so great. As many as possible of the oldest and rarest books were returned to the main library for safe-keeping. While the present floor space occupied by the Bureau of Entomology library is nearly twice as much as it formerly had, the shelf room is practically the same, since the light construction of the building made necessary certain restrictions in the distribution of weight. In October, 1930, the division of agricultural engineering was moved to its new quarters at Thirteenth Street and Pennsylvania Avenue, and with it the library of the division. Larger and better quarters were provided for the library and also 126 linear feet of additional shelving.

LIBRARY STAFF

Thirty-six permanent employees were carried on the staff of the main library at the close of the fiscal year. Seventy were carried by the branch libraries in the bureaus and divisions. Further details are contained in Table 14.

Losses from the library staff as a whole during the past year were fortunately few and except for the transfer of one of our most experienced cataloguers to the library of another Government department, they were in the minor positions. There were three changes in the administrative positions of the bureau and division libraries. The position of librarian of the division of agricultural engineering, which had been vacant for some months, was filled on October 1, 1930, by the transfer to the position of Mrs. D. J. Wilks, formerly assistant librarian of the Bureau of Public Roads. A new position of assistant librarian was created in the Bureau of Animal Industry library and Carolyn R. Ehlert, a cataloguer in the main library, was transferred to the position on June 16. Mrs. H. R. Callahan, librarian of the division of animal husbandry, resigned on August 1, 1930, and her position was filled by Jessie Urner of the division of animal husbandry, who had been in charge of the library previous to Mrs. Callahan's appointment.

It is the general policy of the library to fill branch library positions through transfer from the main library staff. Previous experience in the main library before taking up work in the branch libraries is most helpful as it gives general familiarity with records, procedure, and policies. Likewise, it is helpful for main library assistants to have experience in the branch libraries in order that they may better understand the needs of the bureaus and divisions. No special legislation has, of course, been necessary in regard to permanent transfers from or to the library but in order to carry out the general policy in temporary appointments and to give greater elasticity to the library staff as a whole, a clause was inserted in the library appropriation act of 1912 permitting the temporary detail of library assistants from the main library to the bureaus and from the bureaus to the main library. In accordance with this general policy three

permanent transfers were made during the year from the main library to the branch libraries and an assistant was also temporarily detailed, for three months, from the Bureau of Public Roads library to the main library and in her place an assistant was detailed from the main library to the bureau library.

Staff meetings, attended by staffs of both the main library and the branch libraries, were held each month from October to June. Beginning with January, 1931, the News Letter which had previously been typewritten and read at the staff meetings, has been issued in mimeograph form in order to make it more useful.

The librarian of the department and seven other members of the library staff, including six from the bureaus and one from the main library, attended the annual meeting of the American Library Association in New Haven, from June 21 to June 27. The principal subject discussed by the agricultural libraries section of the association was the relationship of this library to the State agricultural college libraries. Two members of the Bureau of Agricultural Economics library staff attended the annual meeting of the Special Libraries Association in Cleveland, June 10-12. At the meeting of the American Association of Agricultural College Editors in Washington in August, 1930, the librarian of the Office of Experiment Stations presented a paper entitled "A Librarian Looks at Our Publications." The librarian of the department gave a talk on the library before the library school of the New Jersey College for Women at New Brunswick on April 30, 1931. In the last few days of the fiscal year the librarian of the department and the librarian of the Bureau of Entomology visited the C. C. Miller library of apiculture, College of Agriculture, at Madison, Wis., in order to work out a plan of cooperation between that library and the library of the bee culture laboratory of the Bureau of Entomology.

To the diligence, zeal, and loyalty of the library staff, the cooperation of the bureaus and divisions, and the support of the library by administrative officials are due the library's accomplishments of the year. To them grateful acknowledgment is made.

STATISTICS

TABLE 1.—*Accessions, 1930 and 1931*

	1930	1931
Purchases:		
Volumes.....	2,760	2,398
Pamphlets.....	180	179
Maps and charts.....	35	7
Serials and continuations.....	625	757
Total.....	3,600	3,341
Gifts:		
Volumes.....	1,370	1,331
Pamphlets.....	1,387	1,044
Maps.....	52	8
Continuations.....	6,739	6,281
Total.....	9,548	8,664
From binding periodicals and serials:		
Permanently bound.....	1,771	2,848
Binders.....	1,407	1,553
Total.....	3,178	4,401
New current periodicals.....	237	282
Total accessions.....	16,563	16,688

TABLE 2.—*Record of material catalogued, 1930 and 1931*

	1930	1931		1930	1931
Volumes.....	4,130	3,729	Current entries.....	237	282
Pamphlets.....	1,567	1,223	Changed titles.....	96	68
Maps and charts.....	87	15			
Continuations and serials.....	7,364	7,038	Total.....	16,873	16,920
Volumes received from bindery.....	1,771	2,848			
Volumes in binders.....	1,407	1,553	Pamphlets (author cards only)...	206	62
Additions to binders.....	214	164	Reprints (author cards only).....	1,282	1,142

TABLE 3.—*Uncatalogued material, 1930 and 1931*

	1930	1931
Purchases:		
Volumes.....	40	81
Pamphlets.....	4	20
Continuations.....	7	17
Maps.....		14
Gifts:		
Volumes.....	867	1,048
Pamphlets.....	835	1,179
Continuations.....	380	1,352
Maps.....	2	
Total.....	2,135	3,711

TABLE 4.—*Record of titles prepared for printing by Library of Congress in "Agr." series, fiscal years, 1930 and 1931*

	Prepared		Printed	
	1930	1931	1930	1931
Accessions and recatalogued books.....	747	786	685	783
Department publications.....	480	392	412	393
Agricultural periodicals.....	191	150	190	115
Total.....	1,418	1,328	1,287	1,201

TABLE 5.—*Number of cards added to the dictionary catalogue of the main library and to the special catalogues and indexes of the branch libraries¹ of the department, 1930 and 1931.*

Library	1930	1931	Library	1930	1931
Main library, dictionary catalogue.....	20,989	19,055	Forest service.....	8,500	9,000
Bureau of Agricultural Economics.....	12,397	10,370	Bureau of Home Economics.....	1,905	1,032
Bureau of Animal Industry.....	(5)	295	Bureau of Plant Industry.....	26,956	25,111
Bureau of Chemistry and Soils.....	2,248	1,893	Bureau of Public Roads.....	21,460	18,355
Bureau of Dairy Industry.....	1,994	2,249			
Bureau of Entomology.....	18,938	10,141	Total.....	123,381	103,428
Office of Experiment Stations.....	7,994	5,927			

¹ A large proportion of the cards in the branch library catalogues are analytical and index entries for articles in periodicals and are not duplicated in the dictionary catalogue of the main library.

² Net addition, cards added being 25,009 and cards withdrawn 4,020.

³ Net addition, cards added being 21,554 and cards withdrawn 2,499.

⁴ Approximate figures.

⁵ Figures not available.

TABLE 6.—*Total number of cards contained in the dictionary catalogue of the main library and the special catalogues and indexes of the branch libraries¹*

Library	Number	Library	Number
Main library, dictionary catalogue.....	² 700,000	Forest Service.....	² 200,000
Bureau of Agricultural Economics.....	115,541	Bureau of Home Economics.....	17,532
Bureau of Animal Industry.....	202,479	Bureau of Plant Industry.....	² 575,000
Bureau of Chemistry and Soils.....	56,441	Bureau of Public Roads.....	116,903
Bureau of Dairy Industry.....	32,736		
Bureau of Entomology.....	204,237	Total.....	2,309,311
Office of Experiment Stations.....	88,442		

¹ See footnote 1 under Table 5.

² Revised estimate.

TABLE 7.—*Record of periodicals currently received, 1930 and 1931*

Item	1930	1931
Different periodicals received by purchase.....	1,195	1,279
Different periodicals received by gift and exchange.....	2,885	2,904
Total.....	4,080	4,183
Additional copies purchased.....	247	254
Additional copies received by gift and exchange.....	209	227
Total periodicals purchased, including duplicates.....	1,442	1,533
Total periodicals received by gift and exchange, including duplicates.....	3,094	3,131
Total including duplicates.....	4,536	4,664
Dailies received including duplicates.....	128	141

TABLE 8.—*Record of binding, 1930 and 1931*

	1930	1931
Books and periodicals sent to bindery.....	3, 051	¹ 4, 957
Volumes laced into binders.....	2, 429	3, 072
Current serials added to binders.....	1, 139	1, 487
Pamphlets stapled in binders.....	875	854

¹ Includes 1,093 volumes which were prepared for binding during May and June, 1930, but could not be sent to the bindery as department funds for printing and binding were exhausted.

TABLE 9.—*Combined statistics of circulation, 1930 and 1931*

Bureau or office library	Number of books circulated								Current periodicals circulated	Number of borrowers	
	To individuals		To main library		To branch libraries		Total				
	1930	1931	1930	1931	1930	1931	1930	1931	1930	1931	1931
Main library.....	21, 087	22, 644	-----	-----	26, 666	26, 945	47, 753	49, 589	(1)	(1)	1, 376
Agricultural Economics.....	14, 667	16, 441	1, 060	1, 057	114	147	15, 841	17, 645	(1)	(1)	503
Animal Industry.....	2, 667	2, 726	211	208	107	103	2, 985	3, 037	32, 296	30, 244	80
Chemistry and Soils.....	7, 107	7, 071	802	891	40	49	7, 949	8, 011	36, 870	41, 908	333
Dairy Industry.....	2, 203	1, 954	80	97	16	39	2, 299	2, 090	26, 442	29, 762	66
Entomology.....	4, 006	3, 998	402	463	15	1	4, 423	4, 462	6, 939	6, 843	79
Experiment Stations.....	2, 614	2, 991	(1)	(1)	(1)	-----	2, 614	2, 991	30, 312	30, 010	109
Forest Service.....	2, 310	2, 302	270	407	0	1	2, 580	2, 710	9, 716	7, 406	146
Home Economics.....	3, 720	3, 357	368	333	0	-----	4, 088	3, 690	10, 369	11, 079	74
Plant Industry.....	(1)	(1)	(2)	(2)	(2)	(2)	(2)	(2)	36, 763	35, 533	(2)
Public Roads.....	3, 300	5, 056	592	558	(1)	(1)	3, 892	5, 614	15, 324	17, 313	175
Total.....	³ 63, 681	68, 540	3, 785	4, 014	26, 958	27, 285	³ 94, 424	99, 839	205, 031	210, 098	2, 941

¹ Figures not available.

² The Bureau of Plant Industry library does not maintain a collection of books, as it is in close proximity to the main library. The circulation of books to members of the bureau is, therefore, included with those for the main library, but circulation figures are available for current periodicals, as this circulation is handled in the Bureau of Plant Industry library.

³ Revised figures.

TABLE 10.—*Books borrowed from other libraries during 1931*

In Washington:		
Bureau of Fisheries.....	22	
Bureau of Standards.....	44	
Department of Commerce.....	1	
Department of Justice.....	1	
Department of Labor.....	1	
Geological Survey.....	67	
Geophysical Laboratory.....	1	
Library of Congress.....	3,769	
National Institute of Health.....	18	
National Museum and Smithsonian.....	68	
Office of Education.....	10	
Pan American Union.....	4	
Patent Office.....	26	
Public Health Service.....	7	
Public Library.....	9	
Surgeon General's Office.....	498	
Weather Bureau.....	35	
Total.....	4,581	
Outside of Washington:		
American Museum of Natural History.....	2	
Arnold Arboretum.....	2	
Boston Public Library.....	1	
Chemical Abstracts.....	2	
Columbia University.....	4	
Connecticut Academy of Arts.....	1	
Cornell University.....	3	
Department of Genetics, Long Island, N. Y.....	1	
Harvard College.....	6	
F. F. Hill, Ithaca, N. Y.....	1	
Howard Memorial Library.....	1	
Iowa State College.....	4	
John Crerar Library.....	5	
Johns Hopkins University.....	8	
Lloyd Library.....	4	
Massachusetts Horticultural Society.....	11	
Mayo Clinic, Rochester, Minn.....	1	
Metropolitan Museum of Art.....	1	
Missouri Botanical Gardens.....	2	
Museum of Comparative Zoology.....	1	
New York State College of Agriculture.....	1	
Ohio State University.....	1	
Oregon State Agricultural College.....	1	
Peabody Institute.....	1	
Princeton University.....	2	
Science Service.....	1	
University of Chicago.....	3	
University of Georgia.....	1	
University of Illinois.....	3	
University of Michigan.....	1	
University of Minnesota.....	1	
University of Toronto.....	1	
University of Wisconsin.....	1	
Welch Medical Library.....	1	
Yale University.....	1	
Total.....	81	
Total number of books borrowed from libraries in and outside of Washington.....	4,662	

TABLE 11.—*Interlibrary loans outside of Washington, classified by institutions, 1927 to 1931*

Borrowers	1927	1928	1929	1930	1931
Land-grant colleges and experiment stations.....	1,195	1,421	1,186	1,191	1,125
United States Department of Agriculture workers stationed outside of Washington.....	461	525	465	505	583
Colleges and universities other than land-grant colleges.....	112	162	242	281	245
Other scientific institutions.....	220	207	228	251	217
Business firms.....	82	82	136	195	271
Public libraries and miscellaneous.....	88	35	73	121	40
Total.....	2,158	2,432	2,330	2,544	2,481
Photostat copies of articles.....	113	216	230	128	79
Typewritten copies of articles.....	33	38	18	36	11
	2,304	2,686	2,578	2,708	2,571

TABLE 12.—*Interlibrary loans outside of Washington, D. C., 1922-1931*

United States (States, Territories, and island possessions) and foreign countries	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
United States:										
Eastern—										
Connecticut.....	5	5	10	48	53	24	36	24	19	9
Maine.....	1	12	8	1	3	1	10	6	11	
Massachusetts.....	34	37	30	62	62	67	92	116	84	137
New Hampshire.....	11	22	12	6	1	21	19	12	13	21
New Jersey.....	63	107	75	92	78	68	106	67	129	95
New York.....	117	101	136	149	158	188	174	175	217	231
Pennsylvania.....	37	35	60	75	65	35	108	97	102	118
Rhode Island.....	8	1	15	18	4	6	8	2	0	
Vermont.....	12	11	20	14	19	43	14	46	38	18
Total.....	287	319	356	469	455	453	556	555	610	640
Central—										
Illinois.....	17	13	6	25	44	69	27	56	58	59
Indiana.....	7	32	24	23	41	38	58	25	71	60
Iowa.....	59	69	82	76	13	38	42	23	24	34
Kansas.....	23	15	14	18	11	30	14	14	9	20
Michigan.....	24	41	44	39	40	30	63	46	46	34
Minnesota.....	44	60	59	70	77	62	47	66	48	33
Missouri.....	22	21	30	37	54	32	12	42	43	37
Nebraska.....	7	14	10	25	23	33	26	29	13	16
North Dakota.....	10	8	15	10	15	5	15	6	9	8
Ohio.....	35	32	89	86	139	187	161	143	214	200
South Dakota.....	3	1	1	1	1	1	2	1	1	1
Wisconsin.....	63	35	33	88	67	55	74	63	56	82
Total.....	314	340	407	498	524	580	540	515	592	584
Southern—										
Alabama.....	5	6	8	3	13	11	4	8	19	15
Arkansas.....	21	24	23	20	29	47	51	48	32	44
Delaware.....	28	35	84	103	78	75	63	102	131	128
Florida.....	13	33	73	80	73	134	107	114	104	104
Georgia.....	31	15	14	31	35	43	34	44	52	46
Kentucky.....	30	34	49	23	16	24	8	31	50	37
Louisiana.....	15	15	10	13	17	13	14	65	140	97
Maryland.....	17	66	117	65	115	85	105	137	171	126
Mississippi.....	2	2	5	1	2	18	3	5	3	12
North Carolina.....	43	27	48	61	39	64	40	43	95	53
Oklahoma.....	8	5	1	13	15	40	56	31	61	50
South Carolina.....	11	15	22	20	30	26	34	27	44	41
Tennessee.....	12	33	8	8	7	3	7	3	6	21
Texas.....	14	19	19	3	26	17	18	43	26	49
Virginia.....	28	38	40	52	47	109	48	65	28	58
West Virginia.....	15	13	15	16	30	15	18	12	12	22
Total.....	293	380	536	512	572	724	610	778	974	903
Western—										
Arizona.....	1	11	20	5	20	34	18	6	7	
California.....	18	29	52	47	54	53	64	87	63	65
Colorado.....	9	37	13	9	15	39	31	17	12	26
Idaho.....	7	1	4	4	12	24	15	2	32	27
Montana.....	6	38	26	17	25	37	26	33	30	16
New Mexico.....	1	1	2	2	8	2	2	3	3	
Nevada.....	2	1	8	8	35	91	28	31	29	
Oregon.....	30	15	6	8	38	35	91	28	31	29
Utah.....	22	12	45	28	57	47	90	43	31	38
Washington.....	4	7	17	22	39	30	33	49	25	60
Wyoming.....	11	3	7	21	3	5	12	8	4	4
Total.....	109	145	181	178	250	298	398	285	234	275
Territories and island possessions:										
Alaska.....	1					1		1		1
Canal Zone.....									8	
Guam.....					1					
Hawaii.....				1				1		
Porto Rico.....	9	9	20	17	22	13	279	155	24	20
Total.....	10	9	20	18	23	14	279	117	32	21
Foreign countries:										
Canada.....					24	40	44	70	101	57
Cuba.....	1				3	3				
Other countries.....	1		5	12	5	2	5	10	1	1
Total.....	2		5	12	29	45	49	80	102	58
Grand total.....	1, 015	1, 193	1, 505	1, 687	1, 853	2, 114	2, 432	2, 330	2, 544	2, 481

TABLE 13.—Statistics of bureau libraries ¹

	Em- ployees	Books	Pam- phlets	Period- icals cur- rently received	Regis- tered borrow- ers	Regis- tered borrow- ers to whom period- icals are circu- lated	Shelv- ing	Space occu- pied
	Number	Number	Number	Number	Number	Number	Linear feet	Square feet
Agricultural Economics.....	19	² 61, 971		1, 897	503	145	4, 584	5, 092
Cotton marketing divi- sion.....	4	747	(³)	150	47	35	33	576
Animal Industry.....	3	(⁴)		585	80	74	(³)	540
Animal husbandry divi- sion.....	1	4, 599	4, 025	260	64	14	558	630
Chemistry and Soils.....	4	11, 102		580	333	140	1, 770	1, 000
Fertilizer and fixed nitro- gen investigations.....	1	⁵ 4, 000	(³)	67	94	35	520	1, 260
Dairy Industry.....	4	1, 303	5, 200	385	66	60	180	400
Entomology.....	4	11, 737	13, 600	893	79	32	1, 637	2, 240
Bee culture laboratory.....	1	⁵ 2, 000	⁵ 500		⁵ 35		342	400
Experiment stations.....	4	4, 225	71, 744	11, 600	109	61	1, 847	1, 702
Forest Service.....	1	² 26, 573		93	146	69	1, 227	1, 132
Home Economics.....	3	2, 980	(³)	298	74	47	865	945
Plant Industry.....	11	190		697	(³)	175	140	650
Public Roads.....	4	9, 255	17, 180	306	140	118	1, 389	912
Agricultural engineering division.....	1	2, 165	(³)	208	35	26	268	194
Solicitor's office.....	1	5, 150	(³)	4	⁵ 30		1, 300	1, 500

¹ The Weather Bureau library is administered separately, with the exception that the books and periodicals are purchased from the appropriation of the library of the department, the sum of \$1,000 being set aside each year for this purpose.

² Includes pamphlets.

³ Figures not available.

⁴ Does not maintain a collection of books.

⁵ Approximate figures.

TABLE 14.—Library staff of the department

Library	Admin- istra- tive posi- tions	Assist- ants	Clerks	Trans- lators	Mes- sengers	Char- women	Total
Main library.....	4	22	5		2	3	36
Bureau and office libraries:							
Agricultural Economics.....	1	13	4		1		19
Cotton marketing division.....	1	2	1				4
Animal Industry.....	1	2					3
Animal husbandry division.....	1						1
Chemistry and Soils.....	1	2		1			4
Fertilizer and fixed nitrogen investi- gations.....	1						1
Dairy Industry.....	1	1	2				4
Entomology.....	1	2	1				4
Bee culture laboratory.....	1						1
Experiment stations.....	1	5	1		1		8
Forest Service.....	1						1
Home Economics.....	1	1	1				3
Plant Industry.....	1	6	3		1		11
Public Roads.....	1	2	1				4
Agricultural engineering division.....	1						1
Solicitor's office.....	1						1
Total.....	16	36	14	1	3		70
Grand total.....	20	58	19	1	5	3	106

TABLE 15.—*Financial statement, 1922 to 1931*

RECEIPTS

Fiscal year—										
	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931
Source:										
Library appropriation—										
Salaries.....	\$30,060.00	\$32,660.00	\$32,660.00	\$40,000.00	\$38,680.00	\$54,680.00	\$60,000.00	\$69,100.00	\$69,300.00	\$71,860.00
General expenses.....	21,400.00	25,000.00	30,000.00	30,960.00	29,500.00	29,500.00	24,180.00	26,580.00	32,700.00	32,700.00
Total.....	51,460.00	57,660.00	62,660.00	70,960.00	68,180.00	84,180.00	84,180.00	95,680.00	102,000.00	104,560.00
From department printing and binding fund.....	14,549.59	7,460.64	10,621.26	13,171.04	9,983.30	13,173.75	10,045.07	8,199.46	10,614.72	19,944.70
Main library salaries paid by bureaus.....	7,560.02	10,472.89	12,257.50	15,117.84	16,521.50					
Grand total.....	73,569.61	75,593.53	85,538.76	99,248.88	94,684.80	97,353.75	94,225.07	103,879.46	112,614.72	124,504.70

EXPENDITURES

Books and serials.....	\$9,998.58	\$11,182.48	\$11,138.26	\$13,582.31	\$14,710.31	\$14,750.47	\$13,043.14	\$14,817.52	\$18,863.78	\$19,283.23
Periodicals.....	6,353.68	7,008.48	6,916.54	6,937.19	7,184.29	7,517.97	8,845.99	9,061.06	9,431.94	9,273.97
Maps.....	141.88	172.45	147.37	162.45	169.30	137.88	155.41	165.75	149.98	28.50
Furniture, shelving, and miscellaneous equipment.....	29.91	2,435.20	1,738.15	1,908.83	404.77	476.86	1,133.24	821.04	1,569.37	898.32
Traveling expenses.....	190.23	177.52	971.06			78.44	108.04		29.64	78.87
Freight, express, and drayage.....	62.90	13.95	21.51	44.97	42.29	16.52	12.47	20.00	8.88	12.39
Supplies and repairs (itemized below for 1930-31).....	566.76	1,459.67	1,136.98	1,015.01	971.84	1,122.24	1,077.00	1,349.09	1,671.39	880.37
Truck service.....	9.87	52.78	38.89	81.81	85.80	78.87	95.40	107.97	104.12	112.73
Newspapers.....		94.16	90.32	97.80	99.60			809.90	974.91	1,104.87
Salaries (statutory).....	30,059.01	32,219.04	31,960.67	39,799.96	38,613.92	54,065.54	59,655.09	68,526.70	69,252.43	71,665.06
Salaries (miscellaneous).....	3,931.62	2,394.35	7,774.99	6,194.51	5,080.00	5,319.96				
Total.....	51,344.44	57,210.08	61,943.74	69,824.84	67,362.12	83,565.75	84,175.78	95,679.03	101,996.44	103,565.99
Printing.....	1,826.01	579.03	567.97	444.47	477.32	327.96	438.25	553.00	349.43	
Binding.....	12,723.58	6,881.61	10,653.29	12,726.57	9,505.98	12,845.79	9,607.82	7,646.46	10,265.23	
Main library salaries paid by bureaus.....	7,560.02	10,472.89	12,257.50	15,117.84	16,521.50					
Grand total.....	73,454.05	75,143.61	84,822.50	98,113.72	93,866.92	96,739.50	94,221.85	103,878.49	112,611.16	
Credit received for duplicates exchanged with book dealers and libraries.....			954.75	604.35	216.35	653.08	147.30	455.76	335.64	201.96
Gifts.....			12.94	10.75						

1 Less saving of \$250.

2 Outstanding liabilities for books, periodicals, and serials, \$740.01.

Supplies		1930	1931	Repairs		1930	1931
Cleaning and toilet supplies.....		\$95.07	\$84.34	Repairs and alterations:		\$188.13	\$98.88
Stationery.....		214.74	248.22	Carpentry work.....		241.12	43.50
Miscellaneous office supplies.....		289.19	280.01	Electrical work.....		15.43	25.45
Binding material.....		109.47	39.13	Typewriter repairs.....		124.30	14.38
				Painting.....		393.94	76.43
Total.....		708.47	651.73	Miscellaneous repairs.....			
				Total.....		962.92	228.64



REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., August 26, 1931.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1931.

Respectfully,

WM. A. TAYLOR,
Chief of Bureau.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

RESEARCH FOR CROP IMPROVEMENT

In the production of staple crops, and more or less throughout other phases of agriculture, the American farmer is feeling the effects of competition with other agricultural regions of the world. Accordingly, the research activities of the Bureau of Plant Industry during the past year have been especially directed toward the several means for improvement in production, both as to quality of product and in reducing unpredictable fluctuations caused by pests or other hazards, such as weather. The importance of the utilization of better varieties of crop plants is one of the factors in reducing costs of production and at the same time gaining in quality of the crop produced. Obviously the best results can be secured by the simultaneous application of improved cultural practices and adoption of the improved varieties.

It is not always realized that thorough research of the most fundamental character is necessarily the foundation of long-time improvement in agricultural practices. Investigations in plant physiology, genetics, and plant pathology provide the necessary groundwork for the breeding of important crops immune or highly resistant to formerly destructive plant diseases and for the development of cultural practices, spraying materials, and other practical methods for controlling losses from disease. The control of plant diseases through the breeding of resistant varieties is less spectacular than some other agricultural achievements, but the results of recent years establish this as the most economical and most effective method of avoiding increasing losses in regions where climatic and other factors require large acreages of the same crops year after year.

Some examples of the striking results which have been achieved by the bureau during the past year, in many cases in cooperation with different State experiment stations, are briefly recorded in this report. A more complete understanding of the scope of the bureau's investigations, however, may be secured from the appended list of articles by specialists of the bureau issued during the past year.

ORGANIZATION OF THE BUREAU

The work of the bureau has been carried on by the following organization:

Office of the Chief-----	William A. Taylor, chief of bureau. K. F. Kellerman, associate chief of bureau.
Arlington Experiment Farm-----	H. E. Allanson, assistant chief of bureau. E. C. Butterfield, senior horticulturist and superintendent in charge.
Barberry Eradication-----	F. C. Meier, principal pathologist in charge.
Blister Rust Control-----	S. B. Detwiler, principal pathologist in charge.
Botany-----	F. V. Coville, principal botanist in charge.
Cereal Crops and Diseases-----	M. A. McCall, principal agronomist in charge.
Citrus Canker Eradication-----	Directed by associate chief of bureau.
Cotton, Rubber, and Other Tropical Plants-----	O. F. Cook, principal botanist in charge.
Drug and Related Plants-----	W. W. Stockberger, principal physiologist in charge.
Dry Land Agriculture-----	C. E. Leighty, principal agronomist in charge.
Egyptian Cotton Breeding-----	T. H. Kearney, principal physiologist in charge.
Fiber Plant Investigations-----	L. H. Dewey, senior botanist in charge.
Forage Crops and Diseases-----	A. J. Pieters, principal agronomist in charge.
Foreign Plant Introduction-----	K. A. Ryerson, principal horticulturist in charge.
Forest Pathology-----	Haven Metcalf, principal pathologist in charge.
Gardens and Grounds-----	J. W. Byrnes, assistant in charge.
Genetics and Biophysics-----	G. N. Collins, principal botanist in charge.
Horticultural Crops and Diseases-----	E. C. Auchter, principal horticulturist in charge.
Mycology and Disease Survey-----	C. L. Shear, principal pathologist in charge.
Nematology-----	N. A. Cobb, principal nematologist in charge.
Phony Peach Eradication-----	Directed by associate chief of bureau.
Seed Investigations-----	Edgar Brown, principal botanist in charge.
Sugar Plant Investigations-----	E. W. Brandes, principal botanist in charge.
Tobacco and Plant Nutrition-----	W. W. Garner, principal physiologist in charge.
Western Irrigation Agriculture-----	C. S. Scofield, principal agriculturist in charge.

FRUITS

APPLES

PERENNIAL CANKER

Because of its seriousness in the Northwest, much attention has been given to perennial canker, especially in Washington and Oregon. It has been found that infections occur principally during the cooler and showery weather, for instance from October or November to March, while little infection occurs during the summer months. Infections apparently take place usually in wounds of some kind,

pruning wounds frequently being places of entry. Such wounds made just prior to exposure to low temperatures are likely to become infected, whereas those made after the severe winter temperatures are over do not appear to be highly susceptible to infection.

It has been shown also that the woolly aphis is very closely associated with the spread of infection. Callus tissue in healing wounds protected from woolly aphis rarely becomes infected, whereas such tissue without protection from woolly aphis is very likely to become infected following severe freezing. In fact, the perennial character of the disease has been associated with the presence of woolly aphis at points of infection. Control by cutting out diseased tissue has been attempted, but the fact that the mycelium of the organism ordinarily associated with perennial canker may be found in the tissues of the wood as much as a foot from any external visible indication of its presence suggests the impracticability of this method.

Not only are the trees affected, but heavy losses may occur from perennial canker on the fruit. Late applications of Bordeaux mixture will control the disease on the fruit, but there are serious objections to applying this fungicide as late in the season as is required for this purpose.

SPRAY RESIDUES

In the Northwest the problem of removal of spray residue has become somewhat complicated through the use of various oils in the sprays, such oils being used because they make more effective the arsenical sprays in controlling codling moth. Arsenical sprays containing oil are more difficult to remove than those that do not contain oil. As a result, the use of heated washing solutions has become an almost universal practice in the Pacific Northwest as a means of increasing the efficiency of hydrochloric acid in the removal of spray residues. Salt and kerosene emulsion have also been found to facilitate the cleaning of fruit containing heavy deposits of oily residues, particularly mineral oils. Various other substances have also been found effective against the combination of fish oil and lead arsenate residues.

A somewhat different problem involving the washing of fruit was presented in one or two sections as a result of the dust from near-by cement plants heavily coating the fruit. It was found that this dust could be removed satisfactorily by washing with water alone. Rather heavy spraying with arsenicals for the control of curculio and other insects was also necessary. The question arose whether peaches could be satisfactorily washed in the same way as apples. Washing peaches with hydrochloric acid gave unsatisfactory results, as it discolored the fruit. Cold alkaline washes produced no detrimental effect where the fruit was thoroughly rinsed afterwards, but such washes heated to 100° F. were injurious.

BERRIES

NEW VARIETIES

The Blakemore strawberry, introduced commercially in 1929, has thus far met the requirements anticipated for it. During the spring of 1931 in the tidewater region from New Jersey to North Carolina,

inclusive, it commanded a premium on the market as compared with the older commercial varieties commonly grown there.

Another superior strawberry selection, the Redheart, has been introduced on a limited scale in the Pacific Northwest. It has proved thus far to be a superior early market berry for the region and desirable for canning. It seems to be adapted to many different soil types.

At the three centers where the small-fruit work is largely concentrated there are under test during the current season about 78,000 strawberry seedlings, the result of breeding work, and about 9,000 seedlings of raspberries, blackberries, and dewberries.

STRAWBERRY DWARF

The so-called dwarf disease of strawberries, which has become widely distributed in a number of southern strawberry-growing States, has been definitely found to be caused by a nema which lives in the buds. The suspicion that this might be a virus disease, possibly carried by the nema rather than the work of the nema itself, has been eliminated. In a few cases in the far South this disease has resulted in losses of from 50 to 60 per cent, but the losses rarely reach more than 5 or 10 per cent and are usually less than that. At the field laboratory at Chadbourn, N. C., and at other points, investigation is being made to determine the behavior of the disease, the life history and other facts concerning the nema, control methods, and distribution. Roguing, with destruction of the diseased plants, crop rotation, and planting healthy stock on uninfested land are the most promising methods of control. These methods have been commercially successful in controlling dwarf in the leading varieties now grown in the South.

CITRUS

SATSUMA ORANGES

Studies of some of the varieties or strains of Satsuma oranges have contributed information of great promise in stabilizing this phase of the orange industry. An early ripening strain of the Wase variety, designated the Kawano, is proving to be superior in the eastern Gulf coast region for commercial purposes. In the course of bud-selection studies of different strains of the Owari variety, a large-fruited form which matures between the Wase or the Kawano strain and the Owari has been found, and bud wood has been distributed for trial. The strain of the Owari named Silverhill has further demonstrated its unusual degree of hardiness. This makes it superior to the Owari, though otherwise it is very similar to that variety. Thus, with the early ripening Kawano strain, the large-fruited midseason strain, and the Silverhill variety, there seems to be an effective combination of varieties ripening in sequence which covers the normal Satsuma-orange season when relatively few oranges are in the market.

ARTIFICIAL COLORING

The experimental coloring of citrus fruits in different sections, and particularly in the Gulf coast region, has been given more or less attention for several years. This is done to develop the desired color of skin, which oftentimes remains green after the fruit has reached a satisfactory stage of maturity for eating. The coloring methods previously employed in Florida have not been entirely satisfactory, although artificial coloring has become an established practice. The practices followed have resulted in some cases in a lack of uniformity in the coloring and in variable results with respect to subsequent decay in the fruit.

Proper artificial heating of the coloring rooms facilitates the coloring and increases the uniformity of its development. The most satisfactory results were obtained where the ethylene gas used was admitted by the "trickle" system. The saving of time as compared with the "shot" system amounts to about 20 per cent. The use of ethylene by the trickle system colors the fruit in about half the time formerly required by the older methods when kerosene fumes were used. The humidity of the air in the coloring room influences the rapidity of coloring. Humidities below 70 per cent retard the rate of coloring, and excessively low humidities may "set" the green color which it is desired to destroy. Low humidities also result in the wilting of the fruit, while a nearly saturated atmosphere stimulates decay. As between these two extremes it appears that a humidity ranging between 70 and 80 per cent is desirable for short exposures, but for longer periods of treatment a higher humidity is desirable in order to prevent excessive wilting.

CITRUS CANCKER ERADICATION

Conditions during the past year indicate that citrus canker will be entirely eradicated from the United States. It is believed that the eradication of this disease, which, 15 years ago, threatened to destroy the citrus industry of the South, is the result of the intensive campaign conducted by this bureau in cooperation with the Gulf States.

During the past year but one new infection was reported from the commercial producing regions, and this was found in Victoria County, Tex., in July, 1930. Louisiana is still reporting scattered infections in dooryard plantings. Florida, Alabama, and Mississippi are believed to be free of the disease, as these States have not reported any infections for several years, although each State is closely reinspecting all citrus properties to prevent any outbreaks of the disease.

The effectiveness and thoroughness of this campaign is demonstrated when it is considered that in Florida alone, with its large citrus holdings, citrus canker was found at various times on 515 properties scattered through 26 counties. Because of these infections in this State it was necessary to destroy 242,502 grove trees and 2,740,850 nursery trees. Florida has not reported an infection since

1927. Since the beginning of the campaign, in addition to the trees destroyed in Florida, it has been necessary to destroy 854,919 grove and nursery trees in other States, making a total of 3,838,271 trees destroyed in the Gulf States because of citrus canker.

CALIFORNIA REFRIGERATION INVESTIGATION

A special investigation was undertaken by the Bureau of Plant Industry in October, 1928, at the urgent request of the California Citrus League, to determine the minimum amount of refrigeration or protection necessary to deliver California oranges to the eastern market and the most economical means for securing effective refrigeration of the fruit without loss of food value or attractiveness to the consumer. The work has involved the handling under experimental icing of more than 200 refrigerator cars moving over the principal routes and at all seasons of the year. Effective refrigeration of the fruit was secured by a limited icing service, which was as satisfactory as standard refrigeration for shipments requiring not more than 9 to 11 days to reach the market.

The amendment of the National Perishable Protective Tariff, effective on July 20, 1931, provides stated charges for one reicing in transit. The granting of this concession by the carriers enables the shipper to secure at a considerable saving in refrigeration cost the modified icing service demonstrated in the present investigation to be satisfactory for oranges when forwarded in direct shipments to eastern auctions or in connection with the general movement of shipments that have been precooled and pre-iced by the shipper. Under the reduced refrigeration rate, the application of limited icing as developed in the citrus investigation makes possible a saving to the shippers in excess of \$30 per car on through shipments to points on the Atlantic coast.

DATES

An outstanding discovery of the past year in the date work is the practical, beneficial use in commercial date culture of the hitherto unrecognized phenomenon called "metaxenia," a term used to express the varying direct effects of pollen from different palms on the size and shape of the seed and on the size and time of ripening of the fruit. The importance of this discovery is realized only through an understanding of certain facts.

The Deglet Noor variety of date is the one most extensively grown in this country. The fruit that ripens during the warm weather of September is of limited value. The fruit ripening after the coming of the cool weather of December matures very slowly, necessitating the keeping open of packing houses for the purpose of handling relatively small quantities of dates that are harvested from time to time. This is uneconomical and relatively expensive. The fruit ripening in general during October and November comprises the really valuable part of the crop.

It has been known for a long time that the pollen used in fertilizing the blossoms affected the time of ripening, but the fact that this could be taken advantage of in a practical, commercial way was not appreciated until recently. The blossoming period of the Deglet Noor normally extends over a period of several months. It has been demonstrated on a rather large scale that by applying to the

early blossoms pollen that induces late ripening, and to the late blossoms pollen that induces early ripening, practically the entire crop matures during October and November, when the fruit ripens under the most favorable climatic conditions. This development apparently has a far-reaching and practical value.

PEACHES

In cooperation with the Georgia State Board of Entomology, the bureau has just completed the second year of the campaign for the eradication of the phony disease, an infectious virus confined to the root system of peach or nectarine trees, and to other trees grafted or budded on these roots, which causes them to become dwarfed and to produce abnormally small and poorly flavored fruit. A systematic inspection of commercial and home orchards was conducted. During the season the inspectors visited 15,955 orchards and inspected 12,232,895 trees, of which 220,526 were found infected; 216,610 of these infected trees were located in Georgia and 3,383 in Alabama.

It was thought that this disease was confined to Georgia and Alabama, but brief scouting during last season and the early part of the present season disclosed 205 infected trees in Arkansas, 726 in Louisiana, 376 in Mississippi, 27 in North Carolina, 110 in South Carolina, 33 in Tennessee, 321 in Florida, 81 in Texas, and 2 in Illinois. Although some preliminary scouting has been done in the Northern States, the most northern point at which infection has been found up to the present time is Jasper County, Ill.

Because of the fact that the virus causing the phony disease apparently resides only in the roots, the importance of finding a suitable stock for peaches that is resistant to the virus is self-evident. Many stocks tested have proved to be susceptible to the disease. The one outstanding exception is the local wild plum in southern Georgia (*Prunus angustifolia*), which occurs by the thousands along the roadsides and in other similar places in many of the sections where the phony disease has made serious inroads in the peach orchards. Even the wild plum roots become infected with the disease when they are grafted on diseased peach roots. This suggests the probability that the plum is resistant to the natural vector which spreads the disease. While the peach-tree borer is suspected of carrying the disease, definite information with regard to the vector is lacking.

CARBON DIOXIDE AND FRUIT-ROT CONTROL

Special nonreturnable cartons have been developed by the manufacturers for the shipment of strawberries with solid carbon dioxide. These are meeting with some favor in the trade, but tests have given conclusive evidence that the carbon dioxide gas may reach such concentration in these cartons as to be distinctly harmful to the flavor of the fruit. However, there may be advantages in its use when it is properly handled. Better control of rots and of the softening of the fruit has been obtained in the shipment of peaches and berries with a supplemental initial icing of cars with solid carbon dioxide than with the portable car blower or with the use of salt. Experiments in the Northwest with the Italian Prune and with Bartlett and Anjou pears indicate that decay may be materially checked and the storage life of the fruit prolonged by an initial treatment with carbon dioxide.

gas. Soft scald of Jonathan apples may also be reduced by an initial treatment with carbon dioxide. Peas, corn, carrots, and other vegetables retain their sugar content better when given an initial treatment with carbon dioxide where the atmosphere contains a rather high percentage of the gas.

FROZEN-PACK INVESTIGATIONS

Studies of the "frozen-pack" method of preserving fruits and vegetables have been conducted on an extensive scale, not only from the handling standpoint but from the standpoint of microbiology. In canning, the preservation of the product is accomplished through sterilization by heat. The application of heat destroys such microorganisms as may be present as contaminations of the material, and it also stops the action of the enzymes of the cells of the material itself. Both these effects are essential to successful preservation by heat. In the frozen-pack method, the effect upon microorganisms of the application of cold instead of heat is largely unknown, and the relation of microorganisms to the healthfulness of products so preserved consequently remains largely to be determined. This is true not only with respect to the product while it remains in the frozen condition, but also with respect to the development of organisms in it after it has thawed. It is clear that with a considerable number of products, satisfactory preservation of flavor requires the application of some method of treatment that will destroy enzymes, which freezing does not do.

A large number of fruits and vegetables were put up in the season of 1930 for later study with respect to the quality and behavior of the material. Various methods of handling and preparation were followed, and a wide variety of containers were employed. A thorough study of this material with respect to the organisms present and the relation of their character and numbers to the method of preparatory treatment and packing will be made.

PECANS

The pecan investigations have now been extended to practically every representative section throughout the region where the pecan is of commercial importance. Low yield and uncertainty of crop render the industry exceedingly uncertain from an economic viewpoint. The work not only includes the ordinary cultural methods, but studies have also been started to determine the physiological effects of pruning, the relation of plant foods to the storing up of food materials within the tissues of the tree, and in turn the relation of stored-up food materials to production. These investigations are expected to yield results that will serve as a basis on which orchard management practices can be predicated.

In many of the pecan-growing sections scab is a very destructive disease, and under the methods usually employed it has proved very difficult to control. However, under the rainfall conditions of 1930 in southern Georgia four applications of Bordeaux mixture gave at least a 90 per cent control of this disease in experimental orchards where in the same orchards the loss on unsprayed trees was nearly complete. In sections where the rainfall is somewhat limited, three

applications of Bordeaux mixture are adequate for a high degree of protection. In Louisiana under experimental spraying Van Deman pecan trees yielded about 50 pounds of nuts per tree when comparable untreated trees in the same orchard yielded only 8 pounds of nuts per tree.

VEGETABLES

CABBAGE

Seed of the Jersey Queen, a newly introduced variety of cabbage resistant to yellows, has been selected from the Early Jersey Wakefield variety. An increase crop of seed was started in the Puget Sound region in the spring of 1929 with a view to yielding a seed crop in the autumn of 1930 for use in 1931. The stand was nearly destroyed by the severe winter, but a few pounds of seed were obtained by unusual effort. This seed has been placed with growers for limited commercial use, and an ample seed supply for 1932 is expected from the present plantings. The Jersey Queen has proved highly resistant to yellows under conditions where the ordinary Early Jersey Wakefield variety has developed 50 per cent infection.

LETTUCE

In February, 1930, the first two strains of lettuce which are highly resistant to both brown blight and mildew, or "double resistant," were distributed under the designations Imperial F and Imperial C. The latter, so far as tested, seems well adapted to winter-lettuce sections but of doubtful value in the summer lettuce-growing regions, while Imperial F will probably partly fill the very urgent need for a double-resistant strain in the summer-lettuce sections. Certain recently selected strains in the breeding plots, however, give every promise of eventually supplying double-resistant types that are far superior to those now in use, both in regard to adaptation to cultural and climatic conditions and with respect to shipping and eating qualities.

MUSHROOMS

The outstanding problem now confronting the mushroom-growing industry of this country is the rapidly declining supply of horse manure. Experiments with artificial manure have shown that a fair commercial yield of mushrooms can be obtained from a compost made with chopped straw and commercial fertilizers. Although these experiments have already indicated a way to grow mushrooms on a commercial scale without horse manure, thus insuring the perpetuation of the mushroom industry even if the supply of horse manure should disappear, the artificial manure on the average does not yield so many mushrooms as well-composted horse manure. This line of investigation is being continued to develop more satisfactory composts.

POTATOES

Seedlings produced in the potato-breeding work are being given discriminating attention with respect to their resistance to the virus diseases. At least a dozen different forms of virus diseases of the

potato are recognized, but a great deal remains to be learned concerning the manner and means of infection, insect vectors, and other aspects of the diseases. The economic seriousness of some of these is indicated by the fact that percentages representing the reductions in yield obtained from different diseased lots of the Green Mountain variety show 29 per cent reduction for mild mosaic, 25 per cent for leaf-rolling mosaic, 44 per cent for crinkle mosaic, 54 per cent for rugose mosaic, 32 per cent for spindle tuber, and 64 per cent for apical leaf roll. Similar percentages of reduction were shown for the Triumph variety. While a large part of such losses may perhaps be overcome by the use of properly selected seed, the percentages suggest the potential possibilities of loss, and with the wide distribution of the diseases it necessarily follows that the economic losses are large.

The Katahdin potato, recently named and released for extensive cooperative tests in the present season, is the result of many years of critical hybridization and selection of different varieties, conducted in different potato regions of the United States. It has been selected particularly for its resistance to mild mosaic disease. Among other good qualities, it is remarkable for the uniformity in size and shape of the tubers and for uniformity in cooking quality. It is a high-yielding variety, comparable in this respect to Rural New Yorker and Green Mountain, producing tubers of excellent shape and of desirable cooking quality. The Katahdin variety was tested on a small scale in 1930 by a number of private growers in widely separated sections of the country and appears to be well adapted to muck and peat soils but not well suited to regions that have summer droughts. If favorable results are obtained during the present season, a more extensive introduction will be made in 1932.

Sun scald on potatoes is an important problem, especially with the growers of early potatoes in the southern producing areas. It causes heavy losses as a result of the appearance of injury during transit. It apparently results from the exposure of the potatoes to the sun after they are dug and before they are picked up. It has been found that the temperatures of the potatoes when picked up and the subsequent storage temperatures influence the development of injury. Potatoes that have been exposed to the sun, when stored at 90° to 95° F. decay rapidly, whereas similar lots stored at 60° show but little decay. Often exposed potatoes, picked up while hot, decay more rapidly than similar lots left in the field overnight before being picked up.

SWEETPOTATOES

In experiments with sweetpotatoes, potash had no apparent effect on the shape of the roots, but when it was applied in fertilizers varying in amount of potash from 3 to 15 per cent, with other plant-food elements remaining constant, the yields were increased in proportion to the content of potash up to 9 and possibly 12 per cent of potash. From planting experiments made at 15-day intervals from May 15 to July 15, the total yields decreased constantly from the earliest to the latest planting date, as did the yields of the Jumbo and No. 1 grades. Spacing the sets at various distances from 6 to 18 inches apart in the row has no material influence on the percent-

age or yield of No. 1 grade roots, but the closer spacing increases the percentage and the yield of culls by about the same degree that it decreases the oversized roots.

TOMATOES

In tomato breeding, the outstanding recent achievement is the dissemination of the variety Break o' Day. This variety has been widely tested for the past two years and has given unusually good results except under conditions of abnormally high temperature. Excessive heat may prevent the development of the full red color which is typical of the variety under most conditions. Some of the seed supplies of this variety have not been satisfactorily maintained, but where seed of authentic purity has been used it has given exceptionally good results. The fruits are large, globular, red, somewhat similar to Marglobe in appearance, and yield through a long period, as well as being nearly as early as Earliana. The variety is also wilt resistant and is regarded as the most important variety of early tomato produced since the Earliana.

Studies are being continued on the virus diseases of tomatoes in the East, which are economically very serious, in order to determine the manner in which they are carried over winter, the vectors by means of which they are spread, and other information necessary before effective control measures can be developed. It has been ascertained that the virus causing tomato mosaic remains active in the soil under ordinary field conditions for only 30 to 40 days, although it has been repeatedly shown that the virus may live in the soil under greenhouse conditions for 90 to 100 days.

During the summer of 1930 a new type of streak virus was found occurring on tomato plants in Wisconsin and in California. This appears to be identical with spotted wilt, a tomato disease described by Australian workers as causing severe damage in that country. The disease produces a peculiar bronzing of young leaves and a subsequent wilting and death of the tips, small plants being killed. The source of this disease in this country is unknown, also the means by which it is spread. In Australia it is transmitted by a species of thrips, but that species has not yet been reported in the United States where the spotted wilt has been found.

CEREALS

CORN

The yields of crosses developed in the corn-breeding program co-operative with the Iowa Agricultural Experiment Station exceeded the yields of the best open-pollinated varieties in each of the 12 districts of the Iowa corn yield test. The average excess acre yield of the crossed seed was 8.7 bushels, or 13.2 per cent.

Disease-resistant hybrid strains of dent corn, developed in co-operation with the Purdue University Experiment Station in Indiana, outyielded standard commercial varieties. The average yields of the five best hybrids exceeded the yield of the best commercial variety from 8 to 12 per cent. The grain quality of the best commercial varieties, however, was slightly superior to that of the hybrids. In Indiana farm trials, seed produced on detasseled hybrids by cross-

ing with farmers' strains produced crops averaging 6.3 per cent higher in yield than the average yields of farmers' strains.

Striking results have been obtained in the isolation of strains of sweet corn resistant to various diseases. Such lines have been isolated from Golden Bantam, Country Gentleman, and Narrow Grain Evergreen. Golden Bantam ordinarily is most susceptible to bacterial wilt. Selfed lines have been isolated from this variety that are highly resistant to or immune from this disease. Certain of these lines and their hybrids have been widely tested in the central and eastern United States and show a wide range of adaptability. Yields from these hybrids average from 7 to 40 per cent better than those from the best commercial strains of the same variety. The hybrids remain practically free from wilt infection when the disease is highly destructive in commercial strains of Golden Bantam. Some of these lines also are resistant to Diplodia ear rot.

FLAX

The 1930 flax acreage, 4,400,000 acres, was the largest recorded. The extreme drought, however, reduced this to a harvested acreage of 3,946,000 acres. The advantage of early seeding was emphasized by results in 1930.

Bison, a new variety of wilt-resistant flax, selected and distributed by the North Dakota station, is now widely grown. It is estimated that approximately 250,000 acres of this variety were grown in 1930. The 1931 acreage of the Bison variety is considerably greater.

OATS

IMPROVED VARIETIES

A new variety of oats, Brunker, originated in cooperative experiments at the Akron, Colo., field station as a selection from Burt, is proving very promising throughout the central spring-sown red-oat region. This variety is very early, uniform, and awnless, and is of the red-kerneled type. It seems to be particularly well adapted where a variety earlier than Kanota or Fulghum is desired. A smut-resistant selection from a cross between Sixty-Day and Markton, named Carleton, is showing unusual promise in the North Central and Western States. It has outyielded practically all other early varieties and strains in cooperative tests in Iowa, Nebraska, North Dakota, Montana, and Oregon. A pedigreed selection from Nebraska Red Rustproof has shown unusual promise in cooperative experiments in Kansas. This strain is earlier than Kanota, has stiffer straw, and is highly resistant to smut.

STEM RUST

During the year one new form of the oat stem-rust fungus, *Puccinia graminis avenae*, was identified. This form was found in Wisconsin. It is more virulent than any of the other forms commonly found in the United States. This new form attacks the Richland variety, which is highly resistant to all forms heretofore known. A survey of physiologic forms of oat stem rust occurring in the

United States in 1930 indicated that a spread of this rust occurred from south to north. In cooperative rust tests conducted at 44 stations throughout the United States and Canada, some strains of the Green Russian variety showed the highest degree of resistance to stem rust, with Iogold, Anthony, Richland, and a few others showing high resistance.

RICE

IMPROVED VARIETIES

In California at the present time the Caloro and Colusa varieties of rice, originated at the Biggs Rice Field Station, comprise approximately 95 per cent of the total rice acreage. In the spring of 1931 over 160,000 pounds of good Caloro seed rice and 26,000 pounds of good Colusa seed rice were made available to growers by that station.

New early-maturing rice varieties, developed through hybridization, are producing higher average acre yields than the standard early-maturing varieties now grown in California. There has developed a demand for early-maturing medium-grain rices in California, and satisfactory progress has been made in developing such types. An extensive series of hybrids has been made in an effort to develop better varieties both for California and for the southern rice-producing area in Louisiana, Texas, and Arkansas.

EXPERIMENTS WITH PATNA TYPES

There is some demand for adapted rice varieties that can be grown in this country to replace the so-called Patna rice imported duty free for use in canned soups. The Patna rices originate in British India, Burma, and the southeastern Asiatic countries. Sixteen varieties of this type were sown in field tests in 1929 and 1930 in Texas, Louisiana, Georgia, and Florida. Although sown in early spring under favorable conditions, these rices flowered too late in the autumn to produce seed except in southern Florida in 1930, when weather conditions were favorable for seed production throughout November. In southwestern Louisiana, representative of the most important American rice-producing area, these rices did not begin to flower before November 14. The plants were killed by low temperatures before any of them were fully headed.

The results of field tests with Patna rices thus far introduced indicate that these varieties require a longer growing season than prevails in the parts of this country where rice is commercially grown.

SORGHUMS

At Sacaton, Ariz., Fargo Straightneck milo is highly productive under irrigation. Club Kafir is proving highly productive at Hays, Kans. Beaver milo, originated at the Woodward, Okla., field station, is now being grown rather widely in western Oklahoma and Kansas. The Wheatland variety, originated at the same station, was first distributed to farmers in Kansas in 1931. These two varieties were both bred primarily for harvesting with the combine.

The drought of 1930 demonstrated the superiority of grain sorghums over corn under such conditions. At Hays, Kans., grain-sorghum varieties gave yields of from 20 to 60 bushels per acre, compared with corn yields of 19 bushels. A new grain sorghum called Grohoma, widely exploited, was found less drought-resistant than standard varieties. Claims regarding the origin and value of Grohoma were found to be false, exaggerated, or unsubstantiated.

WHEAT

HARD RED WINTER WHEATS

In 1930 the varieties Tenmarq, bred in cooperative experiments at the Kansas station, Oro, selected in cooperative experiments at the Moro., Oreg., branch station, and a selection from Crimean Cheyenne (Nebraska No. 50), from the Nebraska station, proved to be the most promising new varieties in the southern and central United States. Winter-hardy hybrid selections from Minhardi \times Minturki and Minhardi \times Beloglina-Buffum crosses proved most promising for the northern section and were the only varieties that came through with satisfactory stands at several of the stations. If results in 1931 are equally as favorable as heretofore, it is probable that the Tenmarq variety will be distributed from the Kansas station for commercial production.

HARD RED SPRING WHEATS

In the north-central hard red spring wheat area, the breeding program is largely centered around hybrids between the Hope variety and the best commercial varieties, Ceres, Marquis, and Reliance. Hope, in addition to its high resistance to stem rust, is also highly resistant to stinking smut. Certain selections from these crosses have been entirely free from rust under all conditions where tested, and in addition are resistant to stinking smut. The best of these strains also are high yielding and from such information as is available would seem to be of satisfactory commercial quality. The Hope variety also has been crossed with durum, white, hard red winter, and soft red winter wheats, in an effort to transfer the rust and smut resistance of Hope to new varieties of these classes.

SCAB

Wheat scab was less prevalent than usual during the season of 1930, on account of dry weather. In southern Minnesota, southern Wisconsin, and northern Illinois, however, scab occurred with considerable severity. Through a special technic which has been developed, a large number of varieties have been tested for their disease reaction, in cooperation with the Wisconsin and Indiana Agricultural Experiment Stations. Most of the winter-wheat varieties so far tested are susceptible, although certain selections from Michigan Amber, a group of soft red winter hybrids, and one selection from a Turkey hybrid have shown a high degree of resistance. Among the spring wheats, selections from Progress and Illinois No. 1 are highly resistant.

VIRUSES

It has been shown that differences in symptoms resulting from infection with wheat virus are caused by a difference in the viruses present, and to a certain extent by differences in the characteristics of wheat varieties. So far, two distinct wheat viruses have been distinguished, a mild green mosaic and a severe yellow mosaic. On Harvest Queen wheat the mild green type produces a faint light and dark green mottling and severe rosette typical of the rosette occurring in mosaic-infested fields. The yellow mosaic on Harvest Queen causes a severe chlorosis and yellow mottling of the leaves and frequently death of the leaves or even the whole plant. With this mosaic, leaves frequently become rolled, resembling in appearance the leaves of the wild onion. Although the plants may be badly stunted, this stunting does not resemble the rosette caused by green mosaic. On Red Winter spelt, the mild green mosaic causes a more severe mottling than on Harvest Queen, with a slight tinge of yellow, but rosette is never produced. The severe yellow mosaic causes a pronounced yellow mottling and killing of the foliage much as in Harvest Queen but even more severe.

When plants with yellow mosaic survive, the disease becomes gradually less evident, and when the plants attain a height of 10 to 12 inches, the mosaic may become a severe light green and some individual tillers may be entirely mosaic free. Strains of wheat resistant to mosaic and rosette have been isolated, and by the proper choice of varieties this disease can be controlled under field conditions. The Shepherd variety has shown marked resistance to mosaic wherever tested and appears to be a very desirable variety for the present mosaic-infested areas in Illinois and North Carolina.

RUSTS

The relative resistance of wheat varieties to leaf rust is being extensively studied in cooperative experiments at the Kansas station. Certain selections of Mediterranean, Friend, Silversheaf, Hungarian, Winter King, Meno, Ahrens, Grandprize, Fultz, Golden Wave, and Kawvale have shown resistance to all physiologic forms of the disease to which they have been exposed. Resistant varieties have been crossed with commercial varieties of soft red winter wheat that are not resistant to this disease, in an effort to develop high-grade resistant varieties.

BARBERRY ERADICATION

Stem-rust epidemics on wheat and other small grains in the spring-wheat region have decreased with steady progress in the elimination of the common barberry and with wide dissemination among farmers and city people of information concerning the principles of rust control. In the case of wheat, for example, the average annual loss for the period from 1916 to 1920 was estimated at 57,000,000 bushels, while for the 5-year period 1926 to 1930, after millions of barberry bushes had been destroyed, the average annual loss attributed to this disease was estimated at less than 10,000,000 bushels.

During the 1930 field season 168,784 common barberry bushes and seedlings were destroyed, making more than 18,300,000 that had been eradicated since the campaign began in 1918 in the States of Colorado, Illinois, Indiana, Iowa, Michigan, Minnesota, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming. Eradication this year was accomplished primarily by the application of common salt, although kerosene was used to some extent. These chemicals have proved efficient, easily available in all localities, and the most economical of the many tried so far in connection with barberry eradication. A properly treated bush never sprouts; consequently, digging and grubbing are resorted to only when the application of salt or kerosene might be injurious to other shrubbery and trees.

The most recent reports of technical research in rust problems indicate that in nature different strains of stem rust, when growing on leaves of the common barberry, may actually cross or hybridize and produce new strains. The new rust forms or strains produced in this manner, in some instances at least, have the ability to infect grain that has been bred up and selected to be resistant to either of the parent rust forms. These facts indicate that the common barberry during the growing season serves not only as a source of stem-rust spores but can also serve as the special breeding ground where new rust forms may develop from time to time.

FORAGE CROPS

ALFALFA

In spite of the fact that various troubles, especially winter-killing and bacterial wilt, have contributed to the shortening of the life of stands of alfalfa in the United States, the total acreage has gradually increased until in 1930 it amounted to 11,565,000 acres, exceeding that recorded for all other years. The high protective tariff, the Federal seed act, and an abundant domestic supply of seed have resulted in a decrease in the importation of alfalfa seed, but the need for tests to determine the adaptation of alfalfa from various sources remains as great as ever. The results so far have shown that, with the exception of Ontario Variegated alfalfa, most of the imported alfalfas are not wholly satisfactory in the Northern States. Some strains of Turkestan alfalfa are fully as resistant to cold as the hardiest domestic alfalfas, though commonly less productive of forage. These Turkestan alfalfas are, however, subject to leaf-spot diseases and therefore are generally unsatisfactory for humid conditions. The fact that some of the Turkestan alfalfas appear quite resistant to wilt, however, makes them important foundation stocks for combating this disease, which is spreading. Methods of rapid inoculation and testing have been worked out, but the selection and breeding work by which the wilt-resistant quality may be combined with cold resistance, with resistance to other diseases, and with good yielding quality remains to be done.

The continued study of the alfalfa problems on the black limestone soils in Mississippi bears out the previous conclusions that there are several factors contributing to the so-called alfalfa failures. Deep plowing and a liberal use of manure and superphosphate have

increased the yields materially and lengthened the life of the stand. Preliminary results indicate that an application of 250 pounds of superphosphate at seeding time and a top-dressing of a similar amount each spring are preferable to heavier initial or biennial applications. Studies of the alfalfa problem in the Mississippi Delta indicate that one of the most important factors in maintaining stands in this region is good surface drainage. This apparently is more important than underdrainage. Other factors contributing to the alfalfa troubles of that region are wilt, which is not yet very prevalent, insects, poor preparation of the seed bed, and attempts to grow alfalfa on land not well adapted to the crop.

LESPEDeza

During the dry season of 1930 the Korean lespedeza, an early-maturing species (*Lespedeza stipulacea*), introduced by the United States Department of Agriculture, showed unusual capacity to resist drought conditions. In some sections it was the only plant left in pastures during midsummer. The interest in this species has therefore been maintained, and all seed produced in 1930 has found a ready market.

RED CLOVER

The severe drought of 1930 seriously affected not only the new stands of clover and grass but reduced the seed yield for the past season. It has been estimated that in the heart of the red-clover area from 64 to 84 per cent of the current year's seedlings have been lost. The bureau has taken cognizance of this situation and has made recommendations for the use of emergency hay and pasture crops. The total production of red-clover seed also fell to about three-fifths of that for 1929, the decline being due more to a lesser number of acres harvested than to a smaller yield per acre.

An effort is being made to produce seed of the anthracnose-resistant strain of red clover in Oregon and in Idaho. Trials carried on at the Arlington Experiment Farm and at Knoxville, Tenn., indicate that seed of this strain grown for two generations in Oregon, Idaho, and Colorado retains its quality of resistance.

FORAGE SORGHUM

In cooperation with the Texas Agricultural Experiment Station (substation at Chillicothe), a variety of sorghum resulting from the hybridization work was released for distribution this year. This variety, a back cross of Premo (a feterita-kafir hybrid) on Spur feterita, has been named Ajax. It is valuable for both forage and grain, having white seeds and a dwarf but very leafy and sturdy habit of growth. Observers give it high ranking as a bundle feed and predict that it will be an especially desirable type to harvest by pasturing with sheep. In grain yields it has equaled the best strains of Blackhull Kafir at Chillicothe and has also done well at Hays, Kans. Its field of usefulness will no doubt be chiefly in the southern part of the Great Plains under climatic conditions similar to those where it was developed.

SOYBEANS

Considerable increase in the acreage of soybeans for hay and seed was made during the past year. Unusual drought conditions in the States in which the soybean is well adapted brought out the drought-resistant character of the crop, and this has stimulated greater interest in the soybean and brought about a greatly increased acreage in 1931, especially for forage. There has been also a greater utilization of the seed for oil and meal, several oil mills in the Middle Western States and Southern States crushing considerable quantities of domestic-grown beans. The use of the beans and also of the oil cake for human food in the form of flour is being investigated by many large concerns, and soybean flour is being used in the manufacture of several food products.

Investigation of the soybean industry in Japan, Chosen (Korea), Manchuria, and China during the last two years has resulted in the collection of more than 3,000 samples of beans and of 300 products, as well as data on the food and industrial uses of the soybean and its products in the Orient. The collection of seed samples is of special interest, as a wide range of utilization and climatic conditions is represented, and a study of the varieties in the above-named countries indicates that many will be suited for regions in the United States which at the present time are lacking in suitable varieties for forage and food purposes and for the production of oil and meal.

TIMOTHY

Certain experiments on the blooming of timothy have shown an interesting relation between the length of day and earliness in the plant. The season of blooming in the United States progresses from south to north at a constantly accelerating rate, owing to the gradually increasing length of day. The practical application of this fact is that in the southern part of the timothy area early varieties, and in the northern part late varieties, give the best results.

COTTON

COOPERATIVE COMMUNITY PRODUCTION

Continued encouragement has been given by the bureau to community cooperation in the growing of a single superior variety of cotton as a means of improving quality and establishing uniformity of product and thereby obtaining better prices. The present crisis resulting from overproduction of cotton of inferior quality emphasizes the importance and need of such a plan.

Statistics of recent years from manufacturing countries in Europe show a notably increasing use of cottons from other producing countries and a relative decline in the use of American cotton. The loss of our export market is threatened unless the tendencies to deterioration can be checked. American manufacturers are handicapped by the lack of enough good fiber, and much of the American export product is of a grade that comes into direct competition with the very short staples of India and China. The present production of millions of bales of inferior fiber in the United States is a vast and needless waste of farm labor and resources. With better varieties available,

as early and as productive as the very short staples, no agricultural reason exists for planting varieties with less than 1-inch staple in any part of the United States.

A general effort is now being made to establish the production of better qualities of fiber in the United States. Fine fabrics are again in demand as the world recovers from the stress of the war period. Larger quantities of strong and uniform fiber are needed in the automobile industry, and new requirements are being recognized for fabrics of the greatest possible strength in airplanes, balloons, dirigibles, and parachutes.

The first practical step for regional improvement in cotton is dependent upon the adequacy of supplies of select seed year after year, and this is feasible only in communities or districts where the farmers unite upon the production of a single variety.

METAXENIA

A third experiment on the immediate effect of pollen (metaxenia) was conducted in 1930, with results confirming those of the previous experiments. The cottons used in the latest experiment were Pima Egyptian, having an average lint length of $1\frac{9}{16}$ to $1\frac{5}{8}$ inches, and Acala upland, having an average lint length of about $1\frac{1}{8}$ inches. It was found that on the Pima plants the lint from flowers fertilized with Acala pollen averaged three thirty-seconds inch shorter than the lint from flowers fertilized with Pima pollen. On the Acala plants the lint from flowers fertilized with Pima pollen averaged one-sixteenth inch longer than the lint from flowers fertilized with Acala pollen. In other words, pollen of the longer-linted variety lengthened the lint of the shorter-linted variety, and vice versa.

Pima and Acala are the two varieties of cotton grown commercially in the Salt River Valley of Arizona, often in adjacent fields. The occurrence of natural cross-pollination under these conditions has made necessary extraordinary precautions in maintaining stocks of pure planting seed of either variety. The discovery of metaxenia emphasizes the disadvantage of growing different kinds of cotton in the same district. Whether the effect of the foreign pollen is to lengthen the lint of a short-staple variety or to shorten the lint of a long-staple variety, there is a loss of uniformity in the immediate crop, proportional to the degree in which cross-fertilization takes place. The results of this investigation therefore strengthen the argument for reorganizing cotton production throughout the Cotton Belt on the basis of 1-variety communities.

ROOT ROT

For many years root rot has been recognized as a serious disease of cotton, especially in Texas, causing losses also in New Mexico and Arizona, and sometimes attacking other crops as well. Investigations of this disease are being continued at several field stations of the bureau in those States. The recent discovery of hold-over bodies (sclerotia) of the root-rot fungus, *Phymatotrichum omnivorum*, has been extended to many localities and to deeper layers of the soil, sometimes 5 to 6 feet below the surface. The existence of the sclerotia shows that there can be no assurance of

eradicating the disease by any treatment that does not reach the subsoil as well as the surface. Ready germination of sclerotia, even when cut into small fragments, and of small particles of strand material, has been shown in the experiments in Arizona and is further evidence of the ability of the fungus to maintain itself in the soil. Experiments show that disinfection with formaldehyde apparently can be made effective for killing the sclerotia in limited areas, even at depths of several feet, but the expense is too great for general application.

The existence of natural controls of root rot is indicated by the fact that the disease is restricted not only to certain regions but often to particular districts, or to spots in particular fields that remain in nearly the same place through periods of years. Nevertheless the fungus has an extremely wide distribution under natural conditions, from eastern Texas through many of the irrigated valleys of New Mexico and Arizona to southern California in the valley of the Colorado River. Two localities in the Coachella Valley of California, near Indio, are the western extremity of its range as far as known. The finding of the disease in new localities depends to a great extent upon the planting of susceptible crops. No surface indications of the disease may be found under natural conditions, since the fungus grows but little in dry soils and desert plants are seldom killed. But when irrigation is applied and cotton, alfalfa, or fruit trees are planted, a destructive outbreak of root rot may occur.

The discovery of root-rot infection in 1928 on the grounds of the date experiment station at Indio revealed a serious menace to the deciduous-fruit industry of California, since this disease is highly destructive to deciduous fruit trees, and if it became firmly established in the deciduous-fruit regions of that State it would be difficult to estimate the damage that would ensue. Vigorous efforts at checking the spread of the fungus in the soil at the Indio station were undertaken by digging deep trenches and back-filling with mixtures of earth and crude oil as a temporary safeguard. Since it was clear that this could not serve as a permanent barrier, thoroughgoing disinfection of the soil was decided upon as essential. As an area of 5 acres within the date garden was known to be infected, the application of disinfectants was a task of considerable magnitude. A 1.25 per cent solution of formalin was distributed under high pressure in the soil through pointed nozzles at the ends of steel pipes approximately 7 feet in length. These pipes were attached to modern high-pressure spray pumps, and the nozzles functioned as miniature hydraulic boring machines. In this way the formaldehyde solution was distributed to a depth of 6 feet throughout the entire area. The nozzles were inserted every foot in each direction throughout the area, and approximately 1 gallon of solution was applied at each insertion. Accordingly, a little more than 216,400 gallons of solution was applied. The area has been examined at frequent intervals since the treatment, and while mycelium and sclerotia of the root-rot fungus have been found, in all cases the fungus was dead, and it is believed that complete eradication has been accomplished.

SUGAR PLANTS

SUGAR BEETS

Extensive agronomic investigations have shown that improved cropping practices in the western area of the United States will definitely reduce losses from the curly-top disease of sugar beets, even under conditions of rather severe outbreak. In experimental work in Idaho with moderately severe curly top, seasonably early planting accompanied by adequate phosphate fertilizer application gave yields sufficient to provide a profitable crop return, in contrast with an unprofitable crop in the check plots not handled in this manner. Field tests on a large scale confirmed this finding, and this practice is recommended for the Idaho area as suitable for all except the most extreme curly-top conditions. Under conditions of practically maximum curly-top exposure in the areas adjacent to breeding areas of the beet leaf hopper, the differences in favor of the treatment were pronounced, but the crop yields in the treated plots were below an adequate figure. Abundant, timely irrigations and continued care of a threatened crop have given increases in yields over scantily irrigated and uncultivated plots in cases where the onset of curly top occurred in late June or early July. The common practice of neglecting the plantings that are attacked fairly late in the season has been shown to be wasteful and in many cases aggravates the loss situation.

The development of strains of sugar beets resistant to curly top, as a result of many years of work in selection of outstanding individuals from severely affected fields and continued reselection under such conditions, has reached a point where extensive field trials of the resistant stock could be carried out in the important curly-top areas to determine the commercial possibilities of the strain so developed. For this purpose 2,250 pounds of resistant seed were produced by utilizing the method, developed by the department, of seed increase from fall-sown seedlings wintered in the field. The tests in 1930 for the most part were carried on under curly-top conditions. The results show that plants outstanding in resistance predominate in this stock, and under conditions where commercial seed was practically a complete failure the resistant stock produced as a minimum a crop of 6 to 7 tons to the acre. With slightly less severe curly-top exposure the resistant seed has given a crop closely approaching a satisfactory yield, far superior to the commercial seed. Since the great majority of commercial fields rarely are subjected to such extreme conditions as those under which this seed stock was tested, the resistance of the stock may be adequate for practical purposes.

Studies on the distribution of weed hosts of the beet leaf hopper in Idaho, supplemented by pathological studies on the rôle of these weeds in the curly-top situation, have shown the place of these weeds in the plant succession in the breeding grounds of the leaf hopper and have shown that certain weeds of the mustard family are important factors in harboring the curly-top virus. Following the destruction of the original sagebrush formation by agricultural operations, largely during the war period, or the destruction of the

sagebrush or grass cover by overgrazing and by burning, large tracts of land in the Snake River plains of Idaho have grown up to weeds, chiefly mustards, which have greatly augmented the leaf-hopper population by furnishing abundant food supply. The findings indicate clearly that a range-conservation program must be followed to prevent the recurrent appearance of weeds in these large tracts. With such handling of the ranges, better grazing conditions would be afforded and a relatively rapid return to the original sagebrush vegetation fostered.

SUGARCANE

Two additional varieties of sugarcane, C. P. 807 and Co. 281, were released for commercial culture in Louisiana in October, 1930, after careful comparative field tests carried on during the previous three years had proved them to be superior under certain soil and weather conditions to varieties generally grown.

C. P. 807, a seedling bred by the department at Canal Point, Fla., is apparently immune from mosaic and resistant to root-rot organisms. In sugar per acre it outyields the P. O. J. varieties now grown by 900 to 1,500 pounds. The seedling is well adapted to culture on the heavy poorly drained soils comprising approximately 30 per cent of the Louisiana sugarcane area, on which other varieties give poor yields, and the indication is that a more profitable utilization of these lands will result from planting C. P. 807.

Co. 281, a hybrid seedling imported by the department from India, is tolerant of mosaic in about the same degree as the P. O. J. varieties, and in experimental inoculation tests has proved more resistant to red rot than any other variety in commercial culture. It has produced in all tests 500 to 1,000 pounds more sugar per acre than the previously released disease-resisting varieties and is better adapted to cultivation on the lighter soils than on the heavy black soils.

The acreage planted to cane in Louisiana is still short of that planted before the epidemic of mosaic, but the performance of the varieties introduced by the department has restored confidence in the cane crop, and there is a tendency to gradual resumption of planting upon sugarcane lands that have long been idle. In spite of extremely adverse weather conditions, production of sugar in Louisiana in 1930 amounted to 183,693 short tons from 149,217 acres planted to the new varieties, compared with 47,166 short tons from 127,916 acres planted to the old varieties, in 1926.

It has been determined by tests conducted in Georgia and Mississippi that the sugarcane variety C. P. 807 is suitable for culture in the areas where cane is grown for sirup production only. It affords yields of 550 to 650 gallons of sirup per acre, compared with 450 to 550 gallons produced by P. O. J. 213 and Cayana 10, which are now widely planted following their introduction by the department to replace Louisiana Purple when the latter variety failed during the mosaic epidemic. In addition to greatly increased yields of sirup compared with the varieties now in commercial culture, the red color of sirup made from C. P. 807 finds favor with the trade.

TOBACCO

CONTROL OF MOSAIC

A 3-year study of the mosaic disease in the flue-cured tobacco district has shown that this disease is very widespread and seriously affects both the yield and the quality of the crop, the extent of the injury depending on the stage of growth at which infection occurs. Mosaic was found in 20 per cent of the seed beds examined, and the principal cause of infection appeared to be the careless use of manufactured tobacco carrying the virus by growers and laborers while working about the beds. In the field two common sources of mosaic were found to be the use of infected and contaminated seedlings and infested soils previously cropped to tobacco. It was shown that mosaic overwinters in the field in the stubbles of infected plants, and tobacco set in infested fields develops the disease. The infection may also be introduced from near-by infected crops or by the same careless habits that serve to introduce it into seed beds. In 229 selected fields the average amount of infection at about two weeks after transplanting was 3 per cent, and at the beginning of harvest it had increased to 22 per cent. The spread of mosaic in the field tends to follow along the rows.

The evidence indicates that man is the principal agent of dissemination during such operations as hoeing, cultivating, worming, topping, and suckering. Where infested fields are set with healthy seedlings, prompt removal of diseased plants as they are found may greatly restrict the spread of mosaic. The prevention and control of mosaic in the flue-cured district depends primarily on (1) seed-bed sanitation, (2) rotation of crops, (3) field sanitation, and (4) roguing.

Extensive observations on mosaic in Wisconsin indicate that overwintering in infected plant debris in the field also is a common source of heavy mosaic infections in northern tobacco-growing districts.

DOWNY MILDEW

Downy mildew of tobacco, which has not been reported in the United States since 1921, appeared in epidemic form in the spring of 1931. The 1921 outbreak was confined to Florida and adjacent parts of Georgia. In 1931 the disease was found in six States—Louisiana, Georgia, Florida, North Carolina, Virginia, and Maryland. In St. James Parish, La., and Gadsden County, Fla., it appeared in only a few beds. In Georgia it was common in the plant beds of at least 13 counties in the southern part of the State. In North Carolina it was widely scattered in plant beds in 16 counties of the coastal plain region. In spite of the alarming appearance of the disease and its severity in plant beds, the actual commercial damage seems to have been relatively slight.

SYMPTOMS OF DEFICIENCY OF ESSENTIAL ELEMENTS

Symptoms of deficiency of certain essential elements in the tobacco plant have been studied. When grown in a medium deficient in nitrogen, phosphorus, potassium, magnesium, calcium, sulphur, iron,

manganese, or boron, the plant manifests distinctive symptoms on the leaf, stem, or roots, and these symptoms may be used to determine the particular element lacking in a given case. Deficiency symptoms with respect to each of the first five elements enumerated have been found to occur in tobacco soils under certain conditions. A deficient supply of any of the nine elements results in more or less decrease in growth. The chief basis for diagnosing specific deficiencies is the general appearance of the plant and localized effects on the leaves.

RUBBER PLANTS

FRUITING OF TROPICAL RUBBER TREES IN FLORIDA

From the standpoint of possibilities of rubber production, the southern part of Florida must be reckoned as a tropical country, which could supply rubber extensively if that became necessary. The Assam rubber tree, *Ficus elastica*, is commonly planted as a shade tree in Florida, and one of the rubber vines, *Cryptostegia madagascariensis*, is becoming a popular ornamental. All of the principal types of tropical rubber trees, including American, African, and Asiatic species, have produced vigorous individuals, and most of the different kinds have flowered and fruited in Florida. The winter of 1930-31, with unusually protracted periods of moderate cold, caused no damage to the rubber trees. The Ceara rubber tree, *Manihot glaziovii*, produced a large crop of seed during the winter, while two related species also from Brazil, *M. dichotoma* and *M. heptaphylla*, flowered and set fruit in the spring of 1931. The African rubber tree, *Funtumia elastica*, produced seed for the first time in 1930. Another rubber tree from East Africa, *Mascarenhasia elastica*, has flowered and seeded abundantly for several years. The Central American rubber trees (Castilla) are also beginning to fruit, and a few flowers have appeared on the Hevea trees. Any of these trees apparently could be cultivated in southern Florida and utilized at least as emergency sources of rubber.

More attention is being given to the Hevea tree, which apparently resists cold under the Florida conditions as well as or better than the others, and generally seems more promising as a rubber producer. The seedlings do not thrive where they are exposed to the strong sea breezes of the coast districts, but where protection is given and the roots are in reach of moist soil a rapid development occurs, as luxuriant as in the Tropics. Seedlings planted in the spring have shown very vigorous growth which often continues during the following winter. Some of the Hevea seedlings at Chapman Field were more than 7 feet high before they were a year old, and they continued to develop rapidly through the second and third seasons.

HYBRID RUBBER VINES

A notably higher content of rubber is being obtained in Florida from hybrid rubber vines than from either of the parent species. The hybrids are the first generation of a cross between *Cryptostegia grandiflora* and *madagascariensis*. The hybrid plants not only grow much more rapidly than those of the parent species, but yield higher percentages of rubber in proportion to the weight of the dry leaves. The hybrid plants held their leaves till February and

March, while the parent species dropped their leaves in December and January.

Greater vegetative vigor has been reported in numerous experiments with hybrid plants, but an increased proportion of rubber in the *Cryptostegia* hybrids was not expected. The higher content, greater vigor, and longer season of production qualify the hybrids for producing at least three or four times as much rubber as either parent species under southern Florida conditions.

FOREST TREE DISEASES

CHESTNUT BLIGHT

During the last three years a study has been made of the chestnut in Asia, with particular attention to the Japanese Empire as a source of chestnuts for replacing the blight-killed American chestnut. The chestnut blight was found to occur in various parts of Japan and occasionally to injure a tree, but nowhere is it epidemic as in the United States. Apparently the Japanese chestnuts are mostly resistant to the blight, and it is expected that they will retain this resistance in the presence of the chestnut-blight fungus in North America.

From more than 100 picked localities selected strains of chestnut seed were secured from trees of forest type. From this selected seed, and in spite of drought, about 230,000 forest chestnut nursery trees have been grown, and 203,000 of these have been planted throughout the former range of the American chestnut, in localities corresponding climatically with the source of the particular seed in Japan. For the most part they have been set out in forest plantings in public or semipublic forests, where the permanency of the plots is unquestioned and where they can be observed through a series of years.

CONTROL OF SAP STAIN OF LUMBER

The so-called blue stain of sapwood is caused by fungi that enter logs and lumber before they are seasoned and is particularly prevalent in the Southern States. With the increasing proportion of sapwood in lumber, due to the logging of second-growth stands, and the growing insistence of buyers that lumber be free from defect, blue stain has become a factor of great importance, particularly in southern pine and gum. With the assistance and cooperation of the lumber industry, a successful preventive treatment has been developed which costs from 9 to 12 cents per thousand board feet for application.

The larger southern sawmills are rapidly adopting the new methods, particularly for export lumber which is sold in competition with lumber from parts of the world where sap stain is less prevalent. The treatment consists of immersion of freshly cut lumber for 15 seconds in an extremely dilute solution of an organic mercury compound. This treatment not only gives much more effective protection to pine than any previously used, but also protects gum, for which no chemical treatment has previously been available. On gum, a successful treatment with borax has been developed as an alternative method. For the hardwood mills alone the general adop-

tion of these new chemical treatments in place of the more expensive and less effective measures now employed should mean a saving of approximately \$400,000 a year.

DAMAGE BY FOREST FIRES TO BASES OF TREES

The typical ground fire in the forest burns the leaves and litter on the ground but causes no immediately conspicuous damage to most of the larger trees. In a few months the forest appears to the casual observer to be little injured. In fact, however, patches of inner bark have been killed by the fire at the bases of many of the trees, and these patches ultimately appear as visible scars which provide places of entry for heart rot. When wide enough, these killed patches cut down the growth rate of the tree and may ultimately lead to its death. The first intensive investigation of such inner-bark killing on hardwood trees has been made in Virginia, with the active cooperation of the Forest Service. Large differences, some of them previously unexpected, have been found to exist among different timber species in susceptibility to bark killing by fires. The immediately practical results of this study will be the improvement of methods of appraising fire damage to standing timber, and more intelligent distribution of fire-prevention activities in stands of known species, in order to give the most protection to the stands containing the most susceptible species.

WHITE-PINE BLISTER RUST

The outstanding development in the white-pine blister rust situation in the United States during 1930 was the discovery of the rapid and devastating spread of the rust in the chief commercial areas of western white pine, located in northern Idaho and adjacent portions of Washington and Montana. Field studies completed late in the season of 1930 showed that the rust was spreading and intensifying so rapidly that the white pine stands over extensive areas will suffer maximum damage by the rust during the next 10 to 15 years unless this disease is promptly controlled. It can be controlled in pine areas only by systematic eradication or suppression of currant and gooseberry plants (*Ribes* species), the alternate hosts, within and near the pine stands. The comparatively short period of time in which control must be accomplished, together with other unfavorable factors such as the difficult accessibility of many of the pine areas with respect to labor and supplies, the abundance of *Ribes*, and the problems of mixed ownership of large tracts of relatively wild land, make control work more difficult and more costly per acre in Idaho, Montana, and Washington than in the Eastern States. Facts at hand, however, indicate that effective and economical control of blister rust can be accomplished there if known methods of control are systematically applied on an adequate scale. The department, in cooperation with the States and landowners, is planning to apply control measures over the best of the white-pine areas in this region within the next 10 years.

In New England and New York more than 700,000 acres of land were included in *Ribes* eradication work during 1930. Since 1918

control work has been performed on approximately 8,500,000 acres of land in this region. This work is conducted under a cooperative program between the department and the States, by means of which pine owners are led to apply and maintain effective control of the disease. The progress of this control work has been due largely to the aggressive interest and confidence of landowners in the future of white pine as a crop. Timber values in this region are lower now than formerly, but white pine still holds its favored place for timber production and reforestation. The low cost of rust control leaves a good profit in producing white pine in the forest lands of this region.

New Jersey, Pennsylvania, and the Lake States are developing rust-control programs in cooperation with the bureau. The rust is established in these States, and protective measures become increasingly necessary as the idle lands are reforested with white pine.

DUTCH ELM DISEASE

The Dutch elm disease, a destructive European disease, was found in the United States at Cleveland and Cincinnati, Ohio, in the summer of 1930. The Government and Ohio State forces have done a limited amount of field inspection work, which has been supplemented by the results of the examination of hundreds of specimens of suspicious elms sent in by tree surgeons and others. Up to the middle of August, 1931, a total of only eight infected trees had been found, seven of these being at Cleveland and one at Cincinnati. There is no indication as to how the disease entered this country.

BULBS

In the bulb-culture investigations it has been demonstrated that maximum crops of tulip bulbs in the Puget Sound district will be about 70,000 merchantable bulbs to the acre and in addition an abundance of suitable stock for replanting a similar area. A good crop of daffodils will yield an 80 per cent increase in weight of bulbs. In the case of crocus there should be a threefold to fourfold increase, and in iris the weight should be doubled.

It is entirely possible to produce hardy, high-grade daffodils with good forcing and keeping quality in the warm regions along the Atlantic coastal plain as far south as Charleston, S. C. Many varieties now of commercial importance are subject to rotting in warm regions, but there are resistant varieties which are acceptable to the trade and which may be carried in a satisfactory manner with little if any deterioration.

Good progress has been made in the matter of early forcing of daffodil and other bulbs. By the use of proper storage and holding temperatures the bicolor Victoria variety has been brought into commercially acceptable inflorescence by the last of November.

By means of simple and inexpensive antiseptic treatments of narcissus bulbs, either at planting time or before placing in summer storage, it has been possible in experiments to effect a very marked reduction of basal rot. Several tests on a commercial scale have given good control of this disease.

HOPS

A serious threat to one of the old established crops of the Pacific coast suddenly appeared in the Willamette Valley of Oregon and near Puyallup, Wash., with the discovery early in 1930 of downy mildew (*Pseudoperonospora humuli*) in the hop fields in those regions. This disease has long been prevalent in European hop fields and some years ago become established in the fields in British Columbia. The outbreak in Oregon was very severe and caused a considerable reduction in yield. Experimental spraying of infected fields and dusting of crowns is being undertaken in the hope of developing efficient control practices.

SEED INVESTIGATIONS

SEED TESTING

During the fiscal year examinations including identifications, purity analyses, germination tests, and origin determinations were made of 25,137 samples of seed in the seed-testing laboratories at Sacramento, Calif.; Corvallis, Oreg.; Lafayette, Ind.; Columbia, Mo.; and Washington, D. C.

The interpretation of germination tests has been given particular attention, and the importance of making such determinations on the basis of possible agricultural value is being presented at the International Seed Testing Congress in Wageningen, Netherlands, with a view to establishing international reports of seed tests on a basis that will be both uniform and informing to the user of seeds.

ENFORCEMENT OF FEDERAL SEED ACT

IMPORTED SEED

During the year 827 lots of seed, representing 17,250,000 pounds of forage-plant seeds, were offered for entry, of which approximately 500,000 were rejected as not meeting the requirements of the Federal seed act. Of the seeds permitted entry, approximately 42 per cent was clover, 14 per cent each grass and vetch, and 30 per cent winter rape. The amount of seed of alfalfa and red clover colored to indicate origin in foreign countries was 3,000,000 pounds. Of this amount only 233,000 pounds was alfalfa, as compared with a maximum importation of alfalfa seed of 18,000,000 pounds in 1920.

The general quality of crimson-clover seed, red-clover seed, and white-clover seed was relatively low, the average germination of crimson-clover seed being approximately 75 per cent, while that of red-clover seed and of white-clover seed was approximately 80 per cent. Imported vetch seed was of better quality than usually offered, the germination being above 90 per cent.

MISBRANDED SEED

In connection with the enforcement of section 6 of the Federal seed act, providing penalties on misbranding or adulteration of seed in interstate commerce, six lots of seed rye were seized during the year because of having passed in interstate shipment misbranded as

"Abruzzi." Several lots of other seeds were seized, including seed corn and cowpeas, and two cases of criminal prosecution were initiated through the solicitor's office.

The relation of this regulatory activity to the enforcement of State seed legislation has been presented before seed trade groups, State seed commissioners of agriculture, and others, as it is believed that a thorough acquaintance on the part of both the seed trade and State officials with the interstate clause of the Federal seed act will tend in large measure to reduce the interstate shipment of wilfully misbranded seeds.

DRY-LAND AGRICULTURE

The problems of dry-land agriculture investigations, which are conducted by the bureau at 20 field stations in the semiarid region of the United States, are to determine what crops should be grown in each dry-farming section and the cultural practices to follow that will produce the best results. This does not necessarily mean the production of the greatest quantities per acre, but it does mean production at the lowest cost per crop unit. Cost of production may be decreased by the suitability and timeliness of field operations, by the efficiency of machinery, and by efficiency of management. Within the period of a few years revolutionary progress has been made in the machines and operations of dry farming and in the organization of the dry farm as a business unit. Such progress, however, has not been limited to the dry farm or to the United States, and time will be required to tell the extent to which relative positions have been changed. Through its adaptation to large-scale machinery and methods, low cost of production (partly the result of relatively low land values and taxes), and to the large volume of information accumulated by experiments covering a period of 25 years, dry farming in the United States should be at least as well able as any other type of agriculture to meet fair competition.

The dry year of 1930 emphasized the importance of fallow as a cultural method that affords the greatest assurance of crop production under drought conditions. It has a place in the cropping system where drought is normally to be expected. It has proved to be one of the most effective and practical methods for controlling weeds. Fallow reduces the cost of production by distributing labor and permitting the fullest utilization of machinery and equipment. The cost of production of cash crops can also be reduced by combining their production with that of feed crops and the growth of livestock. A striking feature of fallow is the great increase in yields caused by the comparatively small quantity of water stored in excess of that stored by other methods. At representative stations an average increase of 3 bushels of wheat per acre was obtained from each inch of water stored by fallow above the quantity stored in other plots in the spring.

BORON IN IRRIGATION WATERS

As a part of studies of western irrigation agriculture, further exploration has shown that boron as a constituent of irrigation waters occurs in many places throughout California and western

Nevada. It has been found as an important constituent in a number of wells and springs in northern California and in the underground waters of the Lahontan Basin in Nevada, where the Newlands reclamation project is located. In southern California it has been found in a few localities where it was not previously known to occur, and in one of these it has been demonstrated that there are marked differences in the boron concentration of the water in successive strata of gravels tapped by the same wells.

A new method for determining the boron content of irrigation waters has been developed. The findings of the investigational work with respect to the occurrence of boron in irrigation supplies is being utilized by farmers and irrigation companies to minimize losses from this cause, in some cases by eliminating the sources of boron from the irrigation supplies and in others by blending these sources with larger supplies so as to dilute the boron concentration to the point of safety for general use.

Definite progress has been made in the investigations concerning the nature of boron injury to various crop plants and the differences of tolerance of a number of species.

APPARATUS FOR GROWING PLANTS UNDER ACCURATELY CONTROLLED CONDITIONS

In connection with the study of effect of discontinuous light on plant growth, after extensive experimentation an installation has been developed which is suitable for growing plants with artificial illumination under accurately controlled environmental conditions. With this equipment it is possible to grow plants to maturity under a wide range of temperature, intensity, composition, and duration of illumination, and other factors of environment with exceptionally accurate control of these factors, so that experiments may be duplicated at any time.

The outfit comprises essentially a series of eight small illuminated chambers for growing the plants, a system for circulating through the chambers at a definite velocity air that has been accurately conditioned as to temperature and humidity, an automatic watering system for maintaining constant soil moisture and recording transpiration, and a program instrument for automatic control of the light period in each chamber. An important feature is the lighting unit used in the chambers, consisting of a high-power water-cooled lamp. The system of air conditioning employed and the new type of lighting unit afford control of temperature to within a range of about 1° F. and humidity within a range of about 1 per cent.

The equipment is suitable for accurate and expeditious testing of the responses of plants to various environmental factors such as temperature, humidity, carbon dioxide concentration, and duration, intensity, and spectral composition of light. It also appears to be adapted to study of the mineral nutrition of plants under controlled environment.

PUBLICATIONS

Articles and department publications written by workers in the Bureau of Plant Industry were issued during the fiscal year as follows:

FRUITS

- Romans knew their buds. Columella wrote 2,000 years ago of improving fruit trees by selection. *Ariz. Prod.* 10 (2) : 5-6.
- Adjusting orchard practices to meet market requirements. *Kans. State Hort. Soc. Bienn. Rpt.* 40 : 16-25. Also, in part, in *Va. State Hort. Soc. Proc.* (1930) 35 : 202-209.
- Adjusting orchard practices to meet market requirements. *Md. Agr. Soc. Rpt.* (1929) 14 : 254-264. (*Md. State Hort. Soc.*)
- Adjusting orchard practices to meet market requirements. *Penn. State Hort. Assoc. Proc.* 72 : 62, 64-66, 68-69.
- Lessons to be learned from fruit growing practices in the Pacific Northwest. *Penn. State Hort. Assoc. Proc.* 72 : 77-78, 80-82, 84.
- The importance of organic matter in orcharding. *Md. Fruit Grower* 1 : 2-5.
- What should we do to the soil and to the tree to produce fruit of good size and color? *Md. State Hort. Soc. Proc.* 33 : 8-24. Also in *Md. Agr. Soc. Rpt.* (1930) 15 : 154-170.
- Comparison of sprinkler and furrow system of irrigation on water penetration. *Wash. State Hort. Assoc. Proc.* (1930) 26 : 30-37.
- Use of sprinklers in orchard irrigation. *Wash. State Hort. Assoc. Proc.* (1930) 26 : 51-53.
- Observations of apple and pear diseases under overhead irrigation. *Wash. State Hort. Assoc. Proc.* (1930) 26 : 48-50.
- Effect of sprinkler irrigation on arsenical residue. *Northwest Fruit Grower* 3 (1) : 7, 13.
- Lead arsenate oil sprays and residue removal. *Wash. State Hort. Soc. Proc.* (1929) 25 : 69-87.
- Relation of spraying practices to residue removal. *Northwest Fruit Grower* 2 (31) : 19, 32.
- Spray residue removal by latest methods is an economic benefit. *U. S. Dept. Agr. Yearbook* 1931 : 484-487.
- Spray residue removal from apples and pears. *Fruits and Gardens* 46 (8) : 6, 10-11.
- The refrigeration of fruits and vegetables. *Northwest Fruit Grower* 2 (32-33) : 8, 16-17, 24.
- Frozen pack of fruits and vegetables in retail packages. *Wash. State Hort. Assoc. Proc.* (1930) 26 : 213-217.

APPLE

- The size of apple seedlings in relation to the growth of the scion variety. *Amer. Soc. Hort. Sci. Proc.* (1930) 27 : 131-135.
- Factors influencing yield, size, and quality of apples. *Md. Fruit Grower* 1(1) : 6-10.
- Factors influencing yield, size, and quality of apples. *Mass. Fruit Growers' Assoc. Rpt.* 36 : 153-154, 156-161.
- Preliminary report on relation of soil moisture to stomatal activity and fruit growth of apples. *Amer. Soc. Hort. Sci. Proc.* (1930) 27 : 212-218.
- The relation of the distance and direction of the fruit from the leaves to the size and composition of apples. *Amer. Soc. Hort. Sci. Proc.* (1930) 27 : 63-68.
- Stomatal activity in apple leaves. *Amer. Soc. Hort. Sci. Proc.* (1930) 27 : 207-211.
- Progressive changes in the waxlike coating on the surface of the apple during growth and storage. *Jour. Agr. Research* 42 : 705-722. (With *Bur. Chem. and Soils.*)

- Relation of catalase activity to temperature, respiration, and nitrogen fertilization of Grimes Golden apples. *Amer. Soc. Hort. Sci. Proc.* (1930) 27 : 37-42.
- Soil moisture in relation to apple production. *N. Y. State Hort. Soc. Proc.* 76 : 234-239.
- The Ortley and Cleopatra apples. *Fruits and Gardens* 46 (10) : 7. Also in *Better Fruit* 25 (4) : 7, 10.
- Apple blotch. *Calif. Dept. Agr. Mo. Bul.* 19 : 498-500.
- Corticium centrifugum*, a heterothallic pathogene of apples. *Jour. Agr. Research* 41 : 269-294.
- Perennial canker. *Northwest Fruit Grower* 2 (31) : 6.
- Recent studies on perennial canker. *Wash. State Hort. Soc. Proc.* (1929) 25 : 155-166.
- Further observations on the rot of apples caused by *Gloeosporium perennans* and its control. *Northwest Fruit Grower* 2 (34) : 7, 22.
- Studies on infectious hairy root of nursery apple trees. *Jour. Agr. Research* 41 : 507-540. (With *Univ. Wis.*)
- The influence of temperature on the development of watercore. *Northwest Fruit Grower* 3 (1) : 8, 11. Also in *Amer. Soc. Hort. Sci. Proc.* (1930) 27 : 276-280.
- Additional solvents for increasing the efficiency of hydrochloric acid as a cleaning solution for apples. *Northwest Fruit Grower* 2 (35) : 8, 18. (With *Bur. Chem. and Soils.*)
- Newer developments in the washing of fruit. *Md. State Hort. Soc. Proc.* 33 : 64-74. Also in *Md. Agr. Soc. Rpt.* (1930) 15 : 210-219.
- Factors influencing the keeping quality of apples. *Mass. Fruit Growers' Assoc. Rpt.* 36 : 139-148.
- A study of the internal atmosphere of apples in relation to soft scald. *Amer. Soc. Hort. Sci. Proc.* (1930) 27 : 271-275.

AVOCADO

- Avocado culture in Florida. *Fla. Farmer* 34 (7) : 6, 9.

BERRIES

- Berry growing from a national viewpoint. *Wash. State Hort. Assoc. Proc.* (1930) 26 : 187-190.
- Thickness of cuticle in cranberry varieties. *Amer. Cranberry Growers' Assoc. Proc.* (Aug. 1930) 61 : 8-13.
- Identification of false blossom in the fall. *Amer. Cranberry Growers' Assoc. Proc.* (Aug. 1930) 61 : 15-16.
- Cranberry industry in critical state through false-blossom disease. *U. S. Dept. Agr. Yearbook* 1931 : 174-176.
- The spread of cranberry false blossom in the United States. *U. S. Dept. Agr. Circ.* 147.
- The relation of oxygen content of water to flooding injury in cranberry culture. *Amer. Cranberry Growers' Assoc. Proc.* (Jan. 1931) 61 : 6-11, 14.
- The keeping quality of cranberries in the 1929 crop and the use of the incubator test. *New England Cranberry Sales Co. Rpt.* 1929/30 : 33-38.
- Further observations and experiments on the curl disease of raspberries. *Phytopathology* 20 : 787-802.
- Improving strawberry planting stock. *Better Fruit* 25 (6) : 16-17. Also in *Wis. Hort.* 21 : 119.
- Experimental studies on the growth and development of strawberry plants. *Jour. Agr. Research* 41 : 307-325.

Fruit-bud formation in the strawberry in spring in Southeastern States. Science (n. s.) 72:349-350.

Field observations on strawberry dwarf. U. S. Dept. Agr. Circ. 174.

Field observations on strawberry dwarf in North Carolina. Phytopathology 20:669-672.

Notes on flooding injury to strawberries. Phytopathology 20:685-686.

Cleaning up strawberry stock infested with root-gall nemas. Phytopathology 20:919-920.

CHERRY

A study of some unproductive cherry trees in California. Jour. Agr. Research 41:327-335.

CITRUS

Citrus melanose. Calif. Dept. Agr. Mo. Bul. 19:494-495.

Development of the citrus-scab organism, *Sphaceloma fawcettii*. Jour. Agr. Research 42:545-558.

The esthetic side of orange growing in the Southwest, VI-VII. Calif. Citrogr. 16:96-97, 192-193.

An experiment on brushing-out Washington Navel orange trees. Calif. Citrogr. 16:362.

Results of experiments with girdled and not girdled Navel orange trees. Calif. Citrogr. 16:263, 288-289.

A 17-year test of pruned and not-pruned Washington Navel orange trees. Calif. Citrogr. 16:313, 355.

The Silverhill—a new strain of Satsuma orange. U. S. Dept. Agr. Off. Rec. 9 (37):2.

DATE

Experiments on the processing and storing of Deglet Noor dates in California. U. S. Dept. Agr. Tech. Bul. 193.

FIG

The lateral root spread of the fig tree. Amer. Soc. Hort. Sci. Proc. (1930) 27:109-113. (With Tex. Agr. Expt. Sta.)

PEACH

Government investigations of peach stocks. Amer. Nurseryman 52:102.

Another year's experience with zinc-lime as a control for *Bacterium pruni*. Md. State Hort. Soc. Rpt. 32:221-226. Also in Ga. State Hort. Soc. Proc. (1929) 53:32-35; Ind. Hort. Soc. Trans. (1929) 69:110-114.

The cause and contagious nature of the phony disease of the peach. Ga. State Hort. Soc. Proc. (1929) 53:25-32.

The phony disease of the peach. Jour. Econ. Ent. 23:555-562.

Une maladie à virus du pêcher (phony peach). Rev. Path. Vég. et Ent. Agr. 17:383-384.

The peach yellows group of peach diseases. Calif. Dept. Agr. Mo. Bul. 19:484-488.

The canning quality of certain commercially important eastern peaches. U. S. Dept. Agr. Tech. Bul. 196.

PEAR

Control of powdery mildew on Anjou pears. Wash. State Hort. Assoc. (1930) 26:85-86. (With Wenoka Federation.)

Some further observations on the relation of maturity and handling to quality in canned Bartlett pears. Wash. State Hort. Soc. Proc. (1929) 25:52-54.

PLUM

Italian Prune maturity and storage studies in the Yakima Valley. Wash. State Hort. Assoc. Proc. (1929) 25:25-32.

NUTS

Requirements of filberts and other nuts. Wash. State Hort. Assoc. Proc. (1930) 26:218-220.

Growth character, leaf size, and bud development in the pecan. Amer. Soc. Hort. Sci. Proc. (1930) 27:440-443.

Walnut cross pollination makes bigger crops. Natl. Nut News 13(7):41-42.

VEGETABLES

Standardization and description of vegetable varieties. Peninsula Hort. Soc. Trans. 1930:151-155. Also in Md. Agr. Soc. Rept. (1930) 15:330-336. (Md. Veg. Growers' Assoc.)

Type-varieties of vegetables. Amer. Seed Trade Assoc. Proc. (1928) 46:75-77.

Some important vegetable diseases of the Western Hemisphere. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2:271-277.

ASPARAGUS

Asparagus culture. U. S. Dept. Agr. Farmers' Bul. 1646.

BEAN

The bacterial blight of beans caused by *Bacterium phaseoli*. U. S. Dept. Agr. Tech. Bul. 186.

Scab of Canavalia caused by *Elsinoe canavaliae*. Jour. Agr. Research 42:1-12.

Lima-bean scab caused by *Elsinoe*. Jour. Agr. Research 42:13-23.

Additional data on the range and prevalence of Lima-bean scab. (Note.) Phytopathology 21:559.

CABBAGE

A cytological study of cabbage plants in strains susceptible or resistant to yellows. Jour. Agr. Research 41:17-35. (With Univ. Wis.)

Effect of environmental factors upon the resistance of cabbage to yellows. Jour. Agr. Research 41:1-15.

CHAYOTE

Chayote, tropic cucurbit, finds wider market as it becomes better known. U. S. Dept. Agr. Yearbook 1931:138-140.

LETTUCE

Lettuce breeding for disease resistance progresses rapidly. U. S. Dept. Agr. Yearbook 1931:348-350.

MUSHROOM

Some common mushrooms and how to know them. U. S. Dept. Agr. Circ. 143.

A new truffle in beds of cultivated mushrooms. Mycologia 22:223-226.

Two new diseases of cultivated mushrooms. Phytopathology 20:917-919.

Mushroom disease known as "bubbles" controlled by exclusion and eradication. U. S. Dept. Agr. Yearbook 1931:394-396.

ONION

Blemishes and discolorations of market onions. U. S. Dept. Agr. Circ. 135.

PEANUT

Peanut seed may be kept for several years under proper conditions. U. S. Dept. Agr. Yearbook 1931:426-427.
Peanut growing. U. S. Dept. Agr. Farmers' Bul. 1656.

PEPPER

Some conditions affecting the storage of peppers. Jour. Agr. Research 41:295-305.

POTATO

Report of the chairman of the research committee. Potato Assoc. Amer. Proc. (1930) 17:150-154, 156-157, 159-161.
A numbering and recording system for potato breeding. Potato Assoc. Amer. Proc. (1930) 17:128-131. (With Minn. Agr. Expt. Sta.)
The origin by mutation of some American potato varieties. Potato Assoc. Amer. Proc. (1930) 17:117-124.
Recent contributions to potato breeding and related subjects. Potato Assoc. Amer. Proc. (1930) 17:124-128. Also in Amer. Potato Jour. 8:153-158. (With Minn. Agr. Expt. Sta.)
Chromosome behavior and pollen production in the potato. Jour. Agr. Research 41:867-888.
The Katahdin potato: a new variety. Amer. Potato Jour. 8:121-125.
Effect of irrigation water on vigor and vitality of seed potatoes. U. S. Dept. Agr. Tech. Bul. 216.
Potato production in the far Western States. U. S. Dept. Agr. Farmers' Bul. 1639.
Potato production and marketing trends. Amer. Potato Jour. 7:256-261.
Observations on certain virus diseases of potatoes in Florida and Maine. Amer. Potato Jour. 7:187-200. (With Fla. Agr. Expt. Sta.)
Sun-scald injury of potatoes as influenced by solar and sky radiation and storage temperatures. Potato Assoc. Amer. Proc. (1930) 17:102-108.
Storing of cut seed potatoes. Ohio Veg. Growers' Assoc. Proc. 16:40-41.
A simple chemical test for predetermining the culinary quality of potatoes as affected by the accumulation of soluble sugars. U. S. Dept. Agr. Circ. 158. Also, in part, in Ohio Veg. Grow. Assoc. Proc. 16:26-28.
Differences in the cooking quality of potatoes due to storage temperatures. Potato Assoc. Amer. Proc. (1930) 17:109-116. (With Bur. Home Econ.)

SWEET CORN

Growing sweet corn for the cannery. U. S. Dept. Agr. Farmers' Bul. 1634.

SWEETPOTATO

Some effects of chilling temperatures on sweetpotatoes. Jour. Agr. Research 42:617-627.

TOMATO

Studies on bacterial canker of tomato. Jour. Agr. Research 41:825-851.
Effect of shading on the rate of development of tomato yellows. Phytopathology 21:83-87. (With Univ. Calif.)
Experiments on the control of tomato yellows. U. S. Dept. Agr. Tech. Bul. 189.
Tomato ripening after frost requires proper handling and storage. U. S. Dept. Agr. Yearbook 1931:523-525.

CEREALS

Mejora de algunos cereales en los Estados Unidos. Bol. Unión Panamer. 65:228-239.
Height of stubble and straw yields of small grains. Jour. Amer. Soc. Agron. 22:963-967.
Diseases of cereal crops in Pan America. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2:237-242.
The distribution of cereal footrots in the Pacific Northwest. Northwest Sci. 5:10-12.
Stem-rust hazard is reduced by using the proper fertilizers. U. S. Dept. Agr. Yearbook 1931:489-490.
Harvesting small grain, soybeans, and clover in the Corn Belt with combines and binders. U. S. Dept. Agr. Tech. Bul. 244. (With Bur. Agr. Econ. and Bur. Public Roads.)
Relation of dust fungicides to flow of small grains through drills and to drill injury. U. S. Dept. Agr. Circ. 119.
The comparative drought resistance of sorghums and corn. Jour. Amer. Soc. Agron. 22:993-1003.
A statistical study of wheat and oat strains grown in rod-row trials. Jour. Amer. Soc. Agron. 23:118-131.
A cytologic study of wheat \times rye hybrids and back crosses. Jour. Agr. Research 42:341-362.
A genetic study of wheat \times rye hybrids and back crosses. Jour. Agr. Research 42:315-339.
Insect resistance in wheats and sorghums a heritable character. U. S. Dept. Agr. Yearbook 1931:316-317.
The experimental modification of heredity in crop plants. Sci. Agr. 11:557-572, 645-661.

BARLEY

Some growth curves of barley kernels. Plant Physiol. 5:263-272.
Barley in Colorado. Colo. Agr. Expt. Sta. Bul. 371. (In cooperation.)
The effect of boron on powdery mildew and spot blotch of barley. Phytopathology 20:967-972.
Host specialization of barley leaf rust, Puccinia anomala. Phytopathology 20:873-882. (With Ind. Agr. Expt. Sta.)
Seed treatment for controlling covered smut of barley. U. S. Dept. Agr. Tech. Bul. 207.
Effect of depth of seeding on the occurrence of covered and loose smuts in winter barley. Jour. Amer. Soc. Agron. 23:132-141.

CORN

Maize breeding. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2:231-235.
What does hybrid corn mean? Kans. Farmer 69 (6):24.
Recovery following genetic deficiency in maize. Natl. Acad. Sci. Proc. 16:714-720.
The phylogeny of maize. Bul. Torrey Bot. Club 57:199-210.
Accumulated iron in the nodes of corn plants. Plant Physiol. 5:393-398. (With Ohio Agr. Expt. Sta.)
Use of expressed sap in physiologic studies of corn. Plant Physiol. 6:139-148. (With Ohio Agr. Expt. Sta.)
Iowa corn yield test. Results for 1930. Iowa Corn and small Grain Growers' Assoc. Rpt. 11. (In cooperation.)
Some applications of statistical methods to agronomic experiments. Jour. Amer. Statis. Assoc. 25:269-283.

- Variations in stand as sources of experimental error in yield tests with corn. Jour. Amer. Soc. Agron. 23: 469-480.
- The nature of smut resistance in certain selfed lines of corn as indicated by filtration studies. Jour. Agr. Research 41: 613-619.
- Relation between the vigor of the corn plant and its susceptibility to smut (*Ustilago zeae*). Jour. Agr. Research 41: 221-231.
- Drought in 1930 showed some strains of corn to be drought resistant. U. S. Dept. Agr. Yearbook 1931: 198-200.
- Corn more resistant to cold when grown on soil rich in plant food. U. S. Dept. Agr. Yearbook 1931: 160-164.
- Some questions and answers on cold injury to corn. Ill. Farmers' Inst. 14 p. Springfield, Ill. (With Univ. Ill.)
- Pop corn selecting for added popping expansion would pay large growers. U. S. Dept. Agr. Yearbook 1931: 441-443.

FLAX (SEED)

- Flaxseed production by power farming methods in the Northern Great Plains. U. S. Dept. Agr. Farmers' Bul. 1650. (With Mont. Agr. Expt. Sta.)
- Inheritance of immunity from flax rust. Phytopathology 20: 707-721. (With Minn. Agr. Expt. Sta.)

OATS

- Hybrid vigor in oats. Jour. Amer. Soc. Agron. 22: 848-860.
- Fall-sown oat production. U. S. Dept. Agr. Farmers' Bul. 1640.
- Oats of hardier strains needed for fall sowing in the Southern States. U. S. Dept. Agr. Yearbook 1931: 414-416.
- Oats in the Northeastern States. U. S. Dept. Agr. Farmers' Bul. 1659.
- Oat varieties in Colorado. Colo. Agr. Expt. Sta. Bul. 370. (In cooperation.)
- Influence of hulling the caryopsis on covered-smut infection and related phenomena in oats. Jour. Agr. Research 41: 621-633.
- Methods of eradicating buckthorn (*Rhamnus*) susceptible to crown rust (*Puccinia coronata*) of oats. U. S. Dept. Agr. Circ. 133.

RICE

- Sterility in rice hybrids. Jour. Amer. Soc. Agron. 22: 861-867.

SORGHUMS

- Seed treatment and warm soil improve stands of sorghum. U. S. Dept. Agr. Yearbook 1931: 476-478.
- Variability of grain sorghum yields as influenced by size, shape, and number of plants. Jour. Amer. Soc. Agron. 22: 833-838.
- Freezing-point depression and specific conductivity of sorghum tissue fluids. Jour. Agr. Research 42: 57-69.
- Relative susceptibility of varieties of sorghum to rust, *Puccinia purpurea*. Phytopathology 21: 525-550.
- Inheritance of smut resistance and juiciness of stalk in the sorghum cross, Red Amber \times *feterita*. Jour. Heredity 22: 51-56.
- Broomcorn growing and handling. U. S. Dept. Agr. Farmers' Bul. 1631. (With Bur. Agr. Econ.)

WHEAT

- Growth habit and yield in wheat as influenced by time of seeding. Jour. Agr. Research 42: 483-500.

- A successful transfer of emmer characters to vulgare wheat. Jour. Amer. Soc. Agron. 22: 1020-1034.
- Hardiness and yield of winter-wheat varieties. U. S. Dept. Agr. Circ. 141.
- Registration of improved wheat varieties. V. Jour. Amer. Soc. Agron. 22: 1041-1042.
- Titration curves of etiolated and of green wheat seedlings reproduced with buffer mixtures. Plant Physiol. 5: 307-328.
- Some organic acids of wheat plants. Jour. Amer. Chem. Soc. 53: 1040-1043. (With Bur. Chem. and Soils.)
- Inheritance of winter hardiness, growth habit, and stem-rust reaction in crosses between Minhardi winter and H-44 spring wheats. U. S. Dept. Agr. Tech. Bul. 218.
- Differentiation of viruses causing green and yellow mosaics of wheat. Science (n. s.) 73: 650-651.
- Effect of leaf rust infection on yield of certain varieties of wheat. Jour. Amer. Soc. Agron. 23: 1-12. (With Kans. State Agr. Col.)
- Stripe rust, *Puccinia glumarum*, on wheat in Argentina. Phytopathology 20: 981-986. (With Lamson Bros. & Co., Chicago, Ill.)
- Inheritance of resistance to bunt, *Tilletia tritici*, in hybrids of White Federation and Banner Berkeley wheats. Jour. Agr. Research 42: 307-313. (With Calif. Agr. Expt. Sta.)
- Infection phenomena and host reactions caused by *Tilletia tritici* in susceptible and nonsusceptible varieties of wheat. Phytopathology 20: 637-652. (With Oreg. Agr. Expt. Sta.)
- Relation of stinking smut of wheat in the field to smuttness of threshed grain. Plant Disease Rptr. Sup. 79. [Mimeo-graphed.]
- Why so much smut in spring wheat? Plant Disease Rptr. Sup. 77. [Mimeo-graphed.]
- Wheat take-all symptoms compared with injuries caused by chinch bugs. Phytopathology 20: 907-909. (With Kans. State Agr. Col.)
- Goat grass, a new wheat-field weed, is growing troublesome. U. S. Dept. Agr. Yearbook 1931: 277-279.
- Pasturing winter wheat in central Plains pays if properly managed. U. S. Dept. Agr. Yearbook 1931: 424-426.

BARBERRY ERADICATION

- Black stem rust spores combed from the air by fliers. U. S. Dept. Agr. Yearbook 1931: 116-118.
- "Thumbs down" on common barberry. Mich. Farmer 176: 581, 592.

FORAGE CROPS AND GRASSES

- Forage-crop seed's regional origin often revealed by analysis. U. S. Dept. Agr. Yearbook 1931: 250-252.
- Grasses and legumes for warm climates. Inter-Amer. Conf. Agr., Forest and Anim. Indus., Doc. Mater. 2: 171-185.
- Legume and grass seed production in the Pacific Northwest. Seed World 28 (2): 12-13.
- Pasture improvement the first need in strengthening South's livestock industry. U. S. Dept. Agr. Yearbook 1931: 421-424.

GRASSES

- Identifying turf-grass seed. Bul. Green Sect. U. S. Golf Assoc. 10: 39-43. Also in Seed World 29 (5): 16-18.
- Bent seed production in Rhode Island. Bul. Green Sect. U. S. Golf Assoc. 10: 69.

Bentgrass seed production in the Pacific Northwest. Bul. Green Sect. U. S. Golf Assoc. 10: 206-211.

Adulteration and misbranding of seed of Kentucky bluegrass. U. S. Dept. Agr. Serv. and Regulat. Announc., Bur. Plant Indus. (S. R. A.—B. P. I.) 16.

Common wild foxtail grasses. Bul. Green Sect. U. S. Golf Assoc. 10: 62-65.

Searching in the Orient for new turf grasses. (Extract from letter.) Bul. Green Sect. U. S. Golf Assoc. 10: 178-183.

GREEN MANURE AND COVER CROPS

Winter legumes for green manure in the Cotton Belt. U. S. Dept. Agr. Farmers' Bul. 1663. (With Bur. Agr. Econ.)

Austrian winter pea has superior value as a green manure. U. S. Dept. Agr. Yearbook 1931: 104-106.

Crotalaria, a new legume for the South. U. S. Dept. Agr. Circ. 137.

Crotalaria, a new green manure and forage crop, promises well in South. U. S. Dept. Agr. Yearbook 1931: 180-182.

ALFALFA

Ladak alfalfa is a hardy crop for dry-land farmers. Mont. Farmer 18 (13): 5.

Alfalfa dwarf, a hitherto unreported disease. Phytopathology 21: 71-75. (With Calif. Agr. Expt. Sta.)

Quality of alfalfa hay in relation to curing practice. U. S. Dept. Agr. Tech. Bul. 235. (With Nebr. Agr. Expt. Sta.)

LESPEDeza

Lespedeza introduced from Asia thrive in widening area in U. S. U. S. Dept. Agr. Yearbook 1931: 344-348.

SOYBEAN

Photoperiodic response of soybeans in relation to temperature and other environmental factors. Jour. Agr. Research 41: 719-721.

Time to plow under the soybean green manure crop. Sugar Bul. 5 (19): 5-6.

Letter [on soybean in Japan]. Amer. Soybean Assoc. Proc. (1929) 2: 50-52.

La utilización de la soja en diversas industrias. Hacienda 25: 394-396.

SWEETCLOVER

Sweetclover in Corn-Belt farming. U. S. Dept. Agr. Farmers' Bul. 1653.

Sweetclover, though a fertilizer crop, may itself need fertilizer. U. S. Dept. Agr. Yearbook 1931: 496-497.

TIMOTHY

Relation of latitude to time of blooming in timothy. Ecology 12: 182-187.

VETCH

Monantha vetch. U. S. Dept. Agr. Circ. 152.

FIBER PLANTS

Tropical fibers. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2: 412-416.

Abaca growers in Philippines face outside competition. U. S. Dept. Agr. Yearbook 1931: 91-94.

The time to harvest fiber flax. U. S. Dept. Agr. Tech. Bul. 236.

Hemp fiber losing ground, despite its valuable qualities. U. S. Dept. Agr. Yearbook 1931: 285-287.

COTTON

Genetics of cotton. A survey of our present knowledge. Jour. Heredity 21: 325-336, 375-384.

Principles of plant breeding as applied to cotton. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2: 243-249.

Extension of Pearson's correlation method to intraclass and interclass relationships. Jour. Agr. Research 42: 279-291. (With Univ. Minn.)

Development of axillary buds on fruiting branches of Pima and upland cotton. Jour. Agr. Research 41: 697-714.

Flower buds in cotton bolls. Jour. Heredity 21: 275-277.

Early defoliation as a method of increasing cotton yields, and the relation of fruitfulness to fiber and boll characters. Jour. Agr. Research 42: 447-462.

Short branch, another character of cotton showing monohybrid inheritance. Jour. Agr. Research 41: 379-387.

Further studies on the relationship between the concentration of the soil solution and the physicochemical properties of the leaf-tissue fluids of cotton. Jour. Agr. Research 41: 767-788.

Farm study of the cotton plant. U. S. Dept. Agr. Farmers' Bul. 1661.

Cotton more productive when thick spaced for small upright plants. U. S. Dept. Agr. Yearbook 1931: 167-171.

Cotton plants, tame and wild. Jour. Heredity 21: 195-210.

New type Egyptian cotton. Ariz. Prod. 9 (16): 5.

Inequality of cotton fibers. A direct method of comparing substaple. Jour. Heredity 22: 25-34.

Percentage of lint in distributed plats of cotton varieties. Jour. Amer. Soc. Agron. 23: 67-69. (With Tex. Agr. Expt. Sta.)

Cotton diseases and their control. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2: 251-255.

Metaxenia in cotton. Jour. Agr. Research 42: 521-544.

Report of the cotton root-rot conference at Temple, Texas. Phytopathology 20: 889-894. (With Tex. Agr. Expt. Sta.)

Texas root-rot. Calif. Dept. Agr. Mo. Bul. 19: 501-505.

SUGAR PLANTS

BEET

Sugar-beet culture in the humid area of the United States. U. S. Dept. Agr. Farmers' Bul. 1637.

Sugar-beet growing under irrigation in the Utah-Idaho area. U. S. Dept. Agr. Farmers' Bul. 1645.

Proper depth of planting sugar beet seed important. Sugar Beet (Iowa, Minn., N. Dak.) 8 (3): 22-24. Also in U & I Farm Messenger, 1931 (Mar.): 7-9.

Selective thinning of sugar beets. U & I Farm Messenger, 1931 (June): 4-6.

Transplanting sugar beets in Utah and Idaho. U. S. Dept. Agr. Circ. 156.

Plowing depths and fertilizers affect sugar beet crop. Study made near Saginaw in 1930 shows efficiency of these factors. Mich. Agr. Expt. Sta. Quart. Bul. 13: 122-127. (In cooperation.)

First year's results with superphosphate promising. U & I Farm Messenger, 1931 (Feb.): 6-9. Also in Sugar Beet (Utah, Idaho, Mont.) 2 (2): 10-13.

Phytoplasma beticola. Phytopathology 21: 13-40.

Effects of "black root" in beets. Facts About Sugar 26:260-262, 264.
 The late blight of the sugar beet. Phytopathology 21:289-314. (With Utah Agr. Expt. Sta.)
 Sugar-beet strains resistant to leaf spot and curly top. U. S. Dept. Agr. Yearbook 1931:493-496.
 Breeding beets for resistance to the curly-top disease. Sugar Beet (Utah, Idaho, and Mont.) 1 (11):3-5. Also in U & I Farm Messenger 1931 (Jan.):6-7.
 Plant sugar beets early for best results under severe curly top conditions. U & I Farm Messenger 1931 (Mar.):4-6.
 Sugar-beet curly top's spread aided by vast increase in host weeds. U. S. Dept. Agr. Yearbook 1931:491-493.
 Sugar-beet yellows caused by *Fusarium conglutinans* var. *betae*. Phytopathology 21:59-70.
 Methods of seed production from sugar beets overwintered in the field. U. S. Dept. Agr. Circ. 153.
 The relation of type of topping to storage losses in sugar beets. Phytopathology 20:621-635.

SUGARCANE

Some field practices affecting the quality of cane. Sugar Bul. 9:2, 4-5.
 Gaps in stands of sugar cane. Sugar Bul. 9 (11):3-4.
 A comparative study of the stem epidermis of certain sugarcane varieties. Jour. Agr. Research 41:853-865.
 Variety tests of sugarcane in Louisiana during the crop year 1928-29. U. S. Dept. Agr. Circ. 162.
 A sugar cane variety garden in Porto Rico. Facts About Sugar 26:74-75.
 Preliminary results from two "black land" variety tests under severe root disease conditions. Sugar Bul. 8 (24):4-5.

TOBACCO

Tobacco plants spaced close yield more and better flue-cured leaf. U. S. Dept. Agr. Yearbook 1931:522-523.
 Composition and quality of Pennsylvania cigar-leaf tobacco as related to fertilizer treatment. Plant Physiol. 6:177-182. (With Penn. Agr. Expt. Sta.)
 Further studies on aphid transmission of plant viruses. Phytopathology 21:199-211. (With Wis. Agr. Expt. Sta.)
 The present status of the control methods for tobacco diseases. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2:257-264.
 Methods for the quantitative extraction and separation of the plastid pigments of tobacco. Plant Physiol. 5:257-261.

DRUG AND RELATED PLANTS

American medicinal plants of commercial importance. U. S. Dept. Agr. Misc. Pub. 77.
 Poisonous-plant study on livestock ranges involves many problems. U. S. Dept. Agr. Yearbook 1931:439-441.
Linum neomexicanum (yellow pine flax) and one of its poisonous constituents. Jour. Agr. Research 41:715-718.

FOREIGN PLANT INTRODUCTION

Plant material introduced by the Office of Foreign Plant Introduction, Bureau of Plant Industry, April 1, 1929 to December 31, 1929 (Nos. 80019-82599). U. S. Dept. Agr. Inventory 99-101.
 Foreign plant introduction and its contribution to the agriculture of the United States. Inter-Amer. Conf. Agr., Forest, and Anim. Indus., Doc. Mater. 2:155-163.

Introducción de plantas exóticas en Norteamérica. Hacienda 25:486-488.
 [Significance of plant introduction work.] In Waring, H. W., Hunters who search the world for new plants. Amer. Mag. 110 (3):143-144.
 "Plant emigrants." Natl. Hort. Mag. 10:10-13.
 Plant hunting in Madagascar. Sci. Mo. 32:322-345.
 Kalanchoes from Madagascar. Desert 2:127-128.
 More about Malagash succulents. Jour. Cactus and Succulent Soc. Amer. 2:415-417.
 Dwarf coconuts from Malaya. Natl. Hort. Mag. 9:140-143.

ORNAMENTALS

Ornamental planting on golf grounds. Bul. Green Sect. U. S. Golf. Assoc. 10:124-127.
 Lessons from Japanese gardening. (Abstract.) N. Y. Hort. Soc. Yearbook 1930:111-115.
 Azaleas introduced from Japan are suited to wide area in U. S. U. S. Dept. Agr. Yearbook 1931:106-108.
Berberis verna—a critical note. Florists' Exch. 75 (3):27.
 The crape myrtle (*Lagerstroemia indica*). Flower Grower 17:492.
 The Gold Coast jasmin. Natl. Hort. Mag. 9:113-115.
Prunus serrulata Lindl. Oriental cherry. Variety Fugenzo. Natl. Hort. Mag. 9:217-219.
Prunus serrulata Lindl. Variety Ichijo. Oriental cherry. Natl. Hort. Mag. 10:144-146.
Prunus serrulata Lindl. Variety Kwanzan. Oriental cherry. Natl. Hort. Mag. 10:46-48.
Prunus sieboldii Wittmack. Takasago. Natl. Hort. Mag. 9:160.

BULBS

Culture of bulbs for forcing crops. Florists' Rev. 67 (1734):23-24.
 Save calla crop from fungus rot. Florists' Rev. 68 (1743):21-23.
 Daffodils. U. S. Dept. Agr. Circ. 122.
 A score of seedling daffodils. The first report of narcissus breeding experiments as carried on in the Pacific Northwest. Florists' Exch. 77 (7):11.
 Experiments with hot-water treatment of daffodils in relation to forcing and field culture. U. S. Dept. Agr. Circ. 113.
 Daffodil storage and forcing in 1930-31. Florists' Exch. 76 (9):9, 42.
 Daffodil Bicolor Victoria blooms for Thanksgiving. Florists' Exch. 76 (5):15.
 Can the Double Van Sion type of daffodil come back? Seed World 28 (1):13, 23.
 Now you can prevent basal rot in your narcissus! Florists' Exch. 75 (3):11.
 Late forcing of daffodils and hyacinths. Florists' Exch. 76 (15):13.
 Chincherichee—a South African bulb—grows well in the United States. Seed World 28 (2):20-21.
 Prospects for tulip bulb production. Amer. Soc. Hort. Sci. Proc. (1930) 27:326-328.

ROSE

Propagation of roses by budding in the canes. Florists' Exch. 74 (13):25-26.
 Also in Amer. Plant Propagators Assoc. Proc. 1930:7-11; Amer. Soc. Hort. Sci. Proc. (1930) 27:467-470.
 Rose under-stocks in a five-year test. Amer. Soc. Hort. Sci. Proc. (1930) 27:463-466.

The latest news about tests of under-stocks for hybrid tea roses. Florists' Exch. 76 (16): 27, 40.
Development of brown canker of roses. Jour. Agr. Research 42: 293-299.

BOTANY

A botanical trip to South and East Africa. Sci. Mo. 31: 481-507.
A botanical visit to South and East Africa. Smithsn. Inst. Explor. and Field-Work 1930: 113-122.
Four new grasses. Jour. Wash. Acad. Sci. 20: 381-384.
Five new grasses from Colombia. Jour. Wash. Acad. Sci. 21: 14-16.
Plants new to Arizona. (An annotated list of species added to the recorded flora of the State or otherwise interesting.) Jour. Wash. Acad. Sci. 21: 63-80.
A glabrous variety of *Aster concolor*. *Rhodora* 32: 144-145.
The names *Aster ericoides* and *A. multiflorus*. *Rhodora* 32: 136-140.
Two new Asteraceae from Mexico collected by Georges Woronow. Biol. Soc. Wash. Proc. 43: 163-166.
Carex bebbii in eastern Massachusetts. *Rhodora* 33: 63-64.
A new *Limonium* from Haiti. Jour. Wash. Acad. Sci. 21: 12-13.
The typification of *Scirpus capitatus* L. *Rhodora* 32: 182-185.
The control of weeds in the United States. Inter-Amer. Conf. Agr., Forest. and Anim. Indus., Doc. Mater. 2: 167-170.

MYCOLOGY

Entomogenous fungi attack and destroy many harmful insects. U. S. Dept. Agr. Yearbook 1931: 211-214.
Color variations in *Aplanobacter michiganense*. (Note.) Phytopathology 21: 559.
Ephelislike conidia and floret sterility in *Aristida*. Phytopathology 20: 673-675.
Conidial fructifications in *Balansia* and *Dothichloe*. Jour. Agr. Research 41: 761-766.
The relationship between the blue-staining fungi *Ceratostomella* and *Graphium*. Mycologia 22: 175-179.
Gloeosporium rosae Hals., a nomen nudum. Mycologia 23: 223-224.
Studies on the progeny of single-cell isolations from the hairy-root and crown-gall organisms [Phytophomas tumefaciens and *P. rhizogenes*]. Jour. Agr. Research 41: 541-547. (With Univ. Wis.)
Heterothallism in *Puccinia coronata*. Science (n.s.) 72: 536. (With Calif. Agr. Expt. Sta.)
Origin of physiologic forms of *Puccinia graminis* through hybridization and mutation. Sci. Agr. 10: 707-720.
An aberrant physiologic form of *Puccinia triticina* Eriks. Phytopathology 20: 609-620.
Some new species of *Pythium*. Jour. Wash. Acad. Sci. 20: 398-418.
The mechanism of sex in *Uromyces appendiculatus* and *U. vignae*. Jour. Agr. Research 42: 559-587.
Another host for *Ustilago striaeformis* (Westd.) Niessl. (Note.) Phytopathology 21: 241. (With Kans. Agr. Expt. Sta.)
Synthetic nutrient solutions for culturing *Ustilago zeae*. Jour. Agr. Research 41: 435-443.

PLANT DISEASES

Diseases of forest and shade trees, ornamental and miscellaneous plants in the United States in 1928. Plant Disease Rptr. Sup. 73. [Mimeographed.]

Diseases of plants in the United States in 1929. Plant Disease Rptr. Sup. 75. [Mimeographed.]
Some special plant disease surveys in New York State in 1929. Plant Disease Rptr. Sup. 76. [Mimeographed.]
Relation of survey work to a plant disease research and control program. Inter-Amer. Conf. Agr., Forest. and Anim. Indus., Doc. Mater. 2: 29-43.
The preparation of inventories of foreign diseases and pests of economic plants. Inter-Amer. Conf. Agr., Forest. and Anim. Indus., Doc. Mater. 2: 45-46.
The downy mildew of the hop. Calif. Dept. Agr. Mo. Bul. 19: 513-515.
Seed treatment reduces loss from plant diseases. U. S. Dept. Agr. Misc. Pub. 94. (With Off. Coop. Ext. Work.)
The challenge of plant virus differentiation and classification. Science (n.s.) 73: 29-32.
Methods of plant disease control. Inter-Amer. Conf. Agr., Forest. and Anim. Indus., Doc. Mater. 2: 187-194.
Die bedeutung eines pflanzenschutzgesetzes für die europäischen länder. Mitt. Deut. Landw. Gesell. 46: 515-518.

FOREST TREE DISEASES

A forest policy for the United States. Jour. Forestry 28: 436-441.
Forest tree diseases and their control. Inter-Amer. Conf. Agr., Forest. and Anim. Indus., Doc. Mater. 2: 109-116. Also in Jour. Forestry 29: 688-695.
Germination loss of coniferous seeds due to parasites. Jour. Agr. Research 42: 71-92.
The relation of season of wounding and shellacking to callus formation in tree wounds. U. S. Dept. Agr. Tech. Bul. 246.
On changing the direction of sap conducting tissues. *Rhodora* 32: 145-146.
Chestnut blight. U. S. Dept. Agr. Farmers' Bul. 1641.
The Dutch elm disease. U. S. Dept. Agr. Circ. 170. (With Ohio Agr. Expt. Sta.)
A serious elm disease in Ohio. Ohio Agr. Expt. Sta. Bimo. Bul. 150: 105-112. (In cooperation.)
Polyporus dryadeus, a root parasite on white fir. Phytopathology 20: 758-759.
The European larch canker. Calif. Dept. Agr. Mo. Bul. 19: 506-509.
The Woodgate rust. Calif. Dept. Agr. Mo. Bul. 19: 496-497.
Du gui ("On mistletoe") by J. Péter-Contesse. Journ. For. Suisse, vol. 81: 217-223, 247-258. Oct. and Nov. 1930. (Review) Jour. Forestry 29: 402-403.
Control of moisture content of air and wood in fresh-air chambers. Jour. Agr. Research 42: 301-305.
Progress in the use of chemical treatments to protect stored logs from deterioration. Amer. Lumberman, no. 2926: 46-48. Also in South. Lumberman 143(1806): 75-76, 96. (With South. Forest Expt. Sta.)
Prevention of sap stain and mold in southern woods by chemical treatment. South. Lumberman 142(1796): 42-46. (With South. Forest Expt. Sta.)
Relation between moisture content of the wood and blue stain in loblolly pine. Jour. Agr. Research 41: 389-399.
Fungus and termite damage in buildings. Octagon (Jour. Amer. Inst. Architects) 3 (6): 3-7.

WHITE-PINE BLISTER RUST CONTROL

The chemical eradication of *Ribes*. U. S. Dept. Agr. Tech. Bul. 240.
The white pine blister rust situation. Jour. Forestry 29: 181-185.

The status of white pine blister rust in the West. Calif. Dept. Agr. Mo. Bul. 19: 510-512.

Blister-rust control is aided by power devices for spraying host plants. U. S. Dept. Agr. Yearbook 1931: 118-120.

Blister-rust control is effective with public's cooperation. U. S. Dept. Agr. Yearbook 1931: 120-123.

NEMATODES

Some recent aspects of nematology. Science (n. s.) 73: 22-29.

The nematode fauna of the slime flux of the Carolina poplar. Jour. Agr. Research 41: 427-434.

Some nematode parasites (Oxyuridae) of Coleopterous larvae. Jour. Agr. Research 42: 463-482.

Neodiplogaster pinicola, n. sp., a nematode associated with the white-pine weevil in terminal shoots of the white pine. Jour. Agr. Research 41: 125-130.

Predacious nemas of the genus Nygolaimus and a new genus, Sectonema. Jour. Agr. Research 41: 445-466.

Tylenchus alatus n. sp. Harvard Univ. Contrib. Dept. Trop. Med. and Inst. Trop. Biol. and Med. No. 5, 1: 487-489.

SEED TESTING

Seed testing. Inter-Amer. Conf. Agr., Forest. and Anim. Indus., Doc. Mater. 2: 165-166.

Inspection of agricultural seeds. Ind. Agr. Expt. Sta. Circ. 177. (In cooperation.)

Regulations under the Federal seed act. U. S. Dept. Agr. Serv. and Regulat. Announcement, Bur. Plant Indus. (S. R. A. — B. P. I.) 17.

DRY-LAND AND IRRIGATION AGRICULTURE

Wintering steers in the north central Great Plains section. U. S. Dept. Agr. Tech. Bul. 192. (With Bur. Anim. Indus.)

The water requirement of certain crop plants and weeds in the northern Great Plains. Jour. Agr. Research 42: 187-238.

Water requirement, weeds, crops. Dakota Farmer 51: 459, 470.

Determination of boron in natural waters and plant materials. Modification of the Chapin method. Indus. and Engin. Chem. 22: 358-361.

Application of agronomic methods in range research. Ecology 11: 777-782.

EFFECT OF LIGHT PERIODS

Effect of abnormally long and short alternations of light and darkness on growth and development of plants. Jour. Agr. Research 42: 629-651.

Plant-growth possibilities under artificial light. South. Florist 31 (11): 11-12.

Plant growth by artificial light has possibilities. U. S. Dept. Agr. Yearbook 1931: 436-439.

MISCELLANEOUS

Report of the Chief of the Bureau of Plant Industry [for the fiscal year ended June 30, 1930].

A century of field crops. Country Gent. 101 (3): 160.

The debt of agriculture to tropical America. Pan Amer. Union Bul. 64: 874-887.

Hereditary mutations induced in plants by the action of X rays. U. S. Dept. Agr. Yearbook 1931: 287-289.

Heredity, environment and human fate. Jour. Heredity 21: 248-252.

Sexuality in a sea weed. Jour. Heredity 21: 419-420.

Practical aspects of paper mulch. Md. Agr. Soc. Rpt. (1929) 14: 365-383. (Md. Vegetable Growers' Assoc.)

Horticultural practice greatly changed in last quarter century. U. S. Dept. Agr. Yearbook 1931: 305-307.

Horticultural exhibitions. U. S. Dept. Agr. Misc. Pub. 85.

Plant patents: a brief historical survey, with references. U. S. Dept. Agr. Libr., Agr. Libr. Notes 6: 35-42. [Mimeographed.]

A microelectrode for the rapid determination of the hydron concentration of expressed juices from small amounts of plant tissue. Plant Physiol. 5: 249-256.

Apparatus and method for obtaining sterile filtrates of biological fluids. Phytopathology 20: 569-573.

A large sand culture apparatus. Soil Sci. 31: 235-239.

Resistance to tackiness of certain paint, varnish, and lacquer coatings of interior of cedar-lined receptacles. Indus. and Engin. Chem. 22: 1136-1138.

Franklin Sumner Earle, 1856-1929. Phytopathology 20: 923-929.

REPORT OF THE CHIEF OF THE PLANT QUARANTINE AND CONTROL ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
PLANT QUARANTINE AND CONTROL ADMINISTRATION,
Washington, D. C., August 29, 1931.

SIR: I transmit herewith a report of the work of the Plant Quarantine and Control Administration for the fiscal year ended June 30, 1931.

Respectfully,

LEE A. STRONG, *Chief.*

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

Probably the outstanding occurrence during the fiscal year 1931 was the removal of the Mediterranean fruit-fly quarantine. Intensive inspection was conducted throughout the State of Florida from the beginning of the fiscal year to April 1, 1931. From 220 to 750 inspectors were employed and a total of 962,705 specimens were submitted for identification. During the year but one very minor infestation was found, that being at St. Augustine on July 25, 1930. This consisted of two pupae found in the soil below a sour orange that had fallen to the ground in a back yard, and intensive inspection failed to reveal any other evidence of infestation. It seems as reasonable to believe this was an infestation dying out as to believe it was one building up.

On November 15, 1930, the quarantine was removed entirely; on March 31, 1931, all inspection work was discontinued, and by the end of the fiscal year all property, equipment, and offices were disposed of and all personnel dismissed.

During April, 1931, a small lot of grapefruit in storage, grown near Mission, Tex., was found to be infested with the Mexican fruit worm (*Anastrepha ludens*). This was the first finding of the insect in the United States since November 19, 1929, when infestations were found in three back yards in Brownsville, Tex. The last finding of the fly in the vicinity of Mission previous to the 1931 finding was in April, 1929. This may have been an infestation which has persisted since the original discovery in 1927. The range of hosts that this fly attacks and its apparently extremely hardy nature, together with the tremendously increased plantings of citrus in Texas, and the active infestation conditions just across the line in Mexico, make this situation in the lower Rio Grande Valley extremely serious. The Mexican agricultural authorities have cooperated in every possible manner in protecting the American plantings from infestation and have rendered most valuable service. The program under P. A. Hoidale's adminis-

tration heretofore has been inspection, certification, clean culture, and a host-free period of six to seven months. The size of the crop up to this time has permitted the carrying out of such a program, but with greatly enlarged acreage and greatly increased tonnage, both constantly expanding, it is doubtful whether the industry can in the future comply in full with the restrictions that have thus far been in effect.

The noncotton zone created in Arizona in an effort to eradicate the pink bollworm was not the success it was hoped it would be. More highly efficient methods of inspection were developed by R. E. McDonald, in charge of the pink-bollworm project, in the use of gin-trash machines. These and the improved technic developed in laboratory inspection were responsible for finding infestation over a much larger area in Arizona than was anticipated. Infestation was so widespread as to make it seem impracticable to maintain the noncotton zone, and the noncotton restrictions were removed by the State of Arizona December 16, 1930.

An effort was undertaken through State regulation of planting dates and cultural methods to reduce the population of pink bollworms to a point where eradication may again be undertaken. This will require close and continuous cooperation on the part of the growers and the State authorities.

Following the transfer to the Bureau of Entomology of C. H. Hadley, who had been in charge of the work on the Japanese beetle, this work was consolidated with that on the European corn borer under the direction of L. H. Worthley, with general administrative headquarters in South Norwalk, Conn. As the area infested by the Japanese beetle and the European corn borer is enlarged the difficulties involved in enforcing the quarantines are materially increased. That the work has so far been effective and valuable is evidenced by the lack of infestations at long distances from the infested area.

Outstanding as an achievement in quarantine and control work is the apparently complete extermination of the gipsy moth in New Jersey. This is a cooperative undertaking by the Plant Quarantine and Control Administration and the New Jersey State Department of Agriculture. Three million egg clusters were found in 1921 over an area of more than 400 square miles. One egg cluster was found in May, 1929, and none since. Arrangements have been made to consolidate all Federal gipsy-moth headquarters at Greenfield, Mass., the work remaining under the direction of A. F. Burgess.

Distinct and gratifying progress is being made in the eradication of the *Parlatoria* date scale in California and Arizona under the direction of B. L. Boyden in cooperation with the two States named.

The pests intercepted at Canadian and Mexican border ports and at maritime ports of entry by the division of foreign plant quarantines, under the direction of E. R. Sasser, compels interest and emphasizes the importance and efficiency of the work. Incidentally, it is an indictment of the shameful carelessness of this country in permitting unrestricted entry of these pests for so many years. If an earlier effort had been made many of the pests we now have could have been kept out.

The division of domestic quarantines has continued to assist in defining and enforcing domestic quarantine policies. This division, under the direction of S. B. Fracker, has charge of the transit in-

spection work, a function which contributes greatly to the enforcement of all the domestic quarantines.

The many types of treatments applied on a commercial scale by the Plant Quarantine and Control Administration, after being worked out experimentally by the research bureaus of the department, indicated the need for a definite unit to carry on this activity and work out practical field application at the lowest possible cost. The technological division which carried on the treatment on the Mediterranean fruit fly in Florida was therefore set up. Lon A. Hawkins was transferred from the Bureau of Plant Industry to head this division.

S. A. Rohwer, formerly assistant chief of the Plant Quarantine and Control Administration, was transferred on April 1, 1931, to the Bureau of Entomology as assistant chief of that bureau, and on June 29 was succeeded as assistant chief of the Plant Quarantine and Control Administration by Avery S. Hoyt.

DOMESTIC PLANT QUARANTINES

MEDITERRANEAN FRUIT FLY

The apparent success of the eradication measures directed against the Mediterranean fruit fly outbreak in Florida was further evidenced by the results of the inspections carried out during the fiscal year. Only one infestation of this insect was found during that period. It consisted of two pupae discovered under a sour orange tree at St. Augustine on July 25, 1930.

Prior to this, only two infestations had been found since August 27, 1929, one on November 16, 1929, and one on March 4, 1930. Both were in Orange County, where the infestation was originally discovered in April, 1929.

Meanwhile intensive inspections had been carried on by a field force of several hundred trained inspectors covering the entire peninsula of Florida and submitting for identification an average of over 6,000 specimens per working day. In order to be certain that incipient infestations were not being overlooked, this intensive survey program was continued until the end of March, 1931.

Failure to find further infestations during the fall of 1930, and an intensive cooperative bait-spray campaign covering the entire eradication area during July and August, together with adherence to grove sanitation requirements during September, October, and the first half of November, led to repeated modifications of quarantine regulations and the final lifting of the quarantine on November 15.

Nineteen months thus elapsed between the date of discovery of the fruit fly in Florida and the completion of eradication to the extent that the department felt it safe to lift the quarantine regulations.

This Florida outbreak was the first known established infestation of this pest in the continental United States. Subsequent to its discovery this fly was found to cover 72 per cent of the total citrus area of Florida.

The rapid increase in the number of properties found infested after the insect was first discovered in April, 1929, and the equally rapid decrease as the eradication campaign progressed, are shown in Table 1. The names of the 20 counties concerned and the relative degree of infestation in each are shown in the Service and Regulatory

Announcements of the administration for October to December, 1929 (S. R. A.-101, p. 183).

TABLE 1.—*Number of Florida counties and properties found and reported infested with the Mediterranean fruit fly from the date of discovery, April 6, 1929, to December 31, 1930*

1929			1930		
Year and month	Counties	Properties	Year and month	Counties	Properties
	Number	Number		Number	Number
April.....	6	1 364	January.....	0	0
May.....	11	378	February.....	0	0
June.....	14	185	March.....	1	1
July.....	15	64	April.....	0	0
August.....	9	8	May.....	0	0
September.....	0	0	June.....	0	0
October.....	0	0	July.....	1	1
November.....	1	1	August.....	0	0
December.....	0	0	September.....	0	0
			October.....	0	0
			November.....	0	0
			December.....	0	0
			Total.....	20	1,002

¹ The numbers of properties found infested are arranged here as of the date of discovery, rather than the date of identification used in the Service and Regulatory Announcements.

² Excluding duplicates.

APPROPRIATIONS

Field inspection was discontinued on March 27, 1930, on account of scarcity of funds, and was not resumed until June 13. At that time there had become available \$1,740,000 carried in the regular department appropriation bill approved by the President on May 27, 1930. Expenditures during the fiscal year totaled considerably less than this amount and on June 30, 1931, an unexpended balance of approximately \$500,000 of this appropriation reverted to the Treasury. In addition, an emergency fund of \$1,500,000 had been authorized, but none of it was used.

CHANGE OF EXECUTIVE OFFICERS

W. C. O'Kane, who was chairman of the Federal fruit-fly board, appointed by the Secretary of Agriculture in January, 1930, succeeded Wilmon Newell as Federal executive officer of the project on April 1, 1930, and continued in charge until October 15, 1930, when he resumed his duties as State entomologist of New Hampshire.

P. A. Hoidale, in charge of the Mexican fruit-worm project who, from May, 1929, to June, 1930, had directed Mediterranean fruit-fly activities in States other than Florida, was then placed in charge of the work and remained so until the project was closed on June 30, 1931.

FIELD INSPECTION

Field inspection was resumed on June 13, 1930, and by the end of the month 572 inspectors were in the field working under 26 district supervisors and covering the entire peninsular section of Florida, that part of the State lying east and southeast of the Ocklockonee River. An average of 632 inspectors were employed in the field from July 1 to November 15, when the quarantine was lifted.

As a precaution against the spread of any infestation that might develop later, intensive field inspection was continued from November 15 until March 31, 1931, by a force of over 200 inspectors. During

the nine months from July 1 to the end of March, 519,480 property inspections were made and 962,705 specimens submitted for identification, only 2 of which were identified as *Ceratitis capitata*; both of these were pupae.

Because inspection had been discontinued during two and one-half spring months of 1930, the status of the infestation was unknown in June, and the inspection work was resumed with an extensive reconnaissance survey followed by an intensive examination of all host fruits and the inspection and certification of commercial properties. Inspection work of three types was thus carried on during the year.

The first period, midsummer, was devoted to a general scouting of the areas in which infestation seemed most probable, in order to disclose possible heavy infestations.

During the second period, which followed immediately, three complete examinations of host plants were made with intensive inspection of all abandoned properties, back-yard plantings, and commercial groves, two intensive inspections of all wild host plants within 1 mile of recorded previous infestations, as well as a general scouting of the Everglades, all coastal islands, and other jungle areas, much of which probably had never been penetrated by white men before. This intensive inspection resulted in the finding of the only infestation discovered during the fiscal year, namely, the two pupal cases on July 25.

It being evident that no appreciable infestation existed in the regulated area, the third period was confined to intensive inspection of commercial properties preparatory to issuing permits for the interstate shipment of fruit. This included enforcement of grove sanitation and inspection immediately prior to the issuance of shipping certificates.

1930 SPRAY CAMPAIGN

From the beginning of fruit fly work in Florida, the eradication program was built around two intensive features—clean-up and spraying. Both of these activities were carried out in 1929 in as effective a manner and over as wide an area as possible. The beneficial effect of spraying became apparent immediately, and from field observation, as well as from records of traps, it was evident that the fruit-fly population underwent a startling decrease coincident with the spraying activities. The continued failure to find the fly, except in a few isolated places, strengthened the assurance that spraying had been a very effective eradication measure.

Since the 1930-31 appropriation for this project did not provide funds for spray or clean-up activities, except in areas where active infestations existed, a volunteer, cooperative bait-spray program was instituted on July 1 with the object of covering the whole regulated area with two applications of copper carbonate spray. The Florida Growers' Clearing House Association fostered this campaign; the State Plant Board of Florida provided funds to purchase quantities of spray material; various boards of county commissioners provided money for labor and material, while this administration loaned necessary equipment and assisted in organization of the work and in recording progress of the campaign.

The first application was completed by August 10, covering the 36 counties in the regulated area. This area comprised 375,403 acres of citrus and noncitrus host plants. Of this acreage 309,245 acres or 82 per cent of the whole, were sprayed. All counties which had

been generally infested in 1929 were covered to the extent of 90 to 100 per cent of all cultivated citrus and noncitrus hosts. Four of these counties were completely covered. The second application was made during the period August 10 to September 15, and covered 246,169 acres, or 66 per cent of the total. Two complete or almost complete coverages were effected in all the area in which general infestations were found during 1929.

QUARANTINE MODIFICATIONS

Based on findings of the research laboratory and on evident progress of eradication, repeated modifications of quarantine regulations, all tending to lighten the requirements, were made at various intervals throughout the first four and one-half months of the fiscal year, finally terminating in the lifting of the quarantine on November 15. A synopsis of these changes is given later on pages 97 and 98.

QUARANTINE ENFORCEMENT

The interstate movement of host products was controlled (1) by packing-house inspection, (2) by transit inspection, and (3) by road patrol. These activities were discontinued on November 15, 1930, therefore the reports on them during the fiscal year 1931 cover only four and one-half months.

The identity of all host products was maintained from the field through the packing house by a corps of inspectors covering the 342 certified packing houses throughout the fruit-growing area. The issuance of permits for interstate shipment was based on the observance of all quarantine regulations by both the grower and packer. From July 1 to November 15 permits were issued for the interstate shipment of 9,189 carloads and 38,801 boxes of host fruits and vegetables, and 25,000 packages of nursery stock; also for the intrastate shipment of 270 carloads, 2,034 boxes, and 4,129 truckloads of host fruits and vegetables. The details are given in Table 2.

TABLE 2.—Quantities of host fruits, vegetables, and nursery stock certified, and violations intercepted, July 1 to December 31, 1930¹

Item	July	August	Septem- ber	October	Novem- ber	Decem- ber	Total
Certified material:							
Interstate shipments in car lots—							
Citrus.....cars.....	10	3	1,037	4,183	3,858	-----	9,091
Noncitrus fruits.....do.....	14	0	(2)	1	1	-----	16
Vegetables.....do.....	68	0	1	13	0	-----	82
Total interstate shipments by freight.....cars.....	92	3	1,038	4,197	3,859	-----	9,189
Intrastate shipments, freight—							
Citrus.....cars.....	2	0	22	152	92	-----	268
Noncitrus fruits.....do.....	0	0	(2)	1	1	-----	2
Vegetables.....do.....	0	0	0	0	0	-----	0
Total intrastate shipments by freight.....cars.....	2	0	22	153	93	-----	270
Interstate shipments, less than car lots by express—							
Citrus.....boxes.....	1,035	928	449	3,833	4,937	-----	11,182
Noncitrus.....do.....	1,662	3,169	6,856	9,017	2,976	-----	23,680
Vegetables.....do.....	2,265	99	372	1,203	0	-----	3,939

¹ Similar information for the fiscal year 1930 is given in the Service and Regulatory Announcements of the Administration, No. 101, p. 187; and No. 103, p. 36.

² Less than one-half a carload.

TABLE 2.—Quantities of host fruits, vegetables, and nursery stock certified, and violations intercepted, July 1 to December 31, 1930—Continued

Item	July	August	September	October	November	December	Total
Certified material—Continued.							
Intrastate shipments, express—							
Citrus.....boxes..	0	0	26	732	227	-----	985
Noncitrus fruits.....do.....	0	0	213	621	114	-----	948
Vegetables.....do.....	0	0	66	35	0	-----	101
Total interstate and intrastate by express.....boxes.....	4, 962	4, 196	7, 982	15, 441	8, 254	-----	40, 835
Nursery stock, plants, roots, etc., interstate.....boxes.....	2, 700	2, 310	6, 702	11, 388	1, 900	-----	25, 000
Intrastate shipments, highway movement—							
Citrus.....trucks.....	12	10	329	1, 959	1, 816	-----	4, 126
Vegetables.....do.....	3	0	0	0	0	-----	3
Sterilization—							
Citrus.....boxes.....			25	0	0	-----	25
Noncitrus.....do.....			167	0	0	-----	167
Property inspections—							
Total host properties ³							212, 163
Host-property inspections.....	81, 803	95, 269	115, 866	97, 911	37, 619	49, 810	478, 278
Violations:							
Express shipments intercepted at Jacksonville and returned to shipper as violations of regulations—							
Without permits.....boxes.....	55	59	29	37	18	-----	198
Concealed shipments.....do.....	2	19	32	97	32	-----	182
Miscellaneous.....do.....	4	1	2	0	0	-----	7
Irregularities corrected and passed.....do.....	18	53	14	1	3	-----	89
Total express violations.....do.....	79	132	77	135	53	-----	476
Freight shipments—permit irregularities corrected and passed.....car lots.....	1	0	8	38	20	-----	67

³ "Host properties" are properties upon which existed trees or plants that produce fruit which is a host of the Mediterranean fruit fly.

Transit inspectors were stationed at railway, express, and steamship transfer points in Florida and adjacent States to prevent interstate shipment of host products which were not moving in accordance with the regulations. In carrying out this work, 476 express and 67 car-lot freight shipments moving in violation of the quarantine were intercepted. Of these shipments, 387 express shipments were returned to shipper and 89 were passed to destination. The irregularities involved in the car-lot interceptions were corrected and passed.

The interstate movement of host fruits and vegetables from Florida by means of road vehicles was prohibited prior to November 5, at which time the regulations were amended to allow interstate road movement of Florida fruits under restrictions. A border patrol was maintained by the administration along the north boundary of the regulated area until the quarantine was lifted. This consisted of 18 road stations along the Georgia-Florida border and 7 on highways crossing the Ocklockonee River. In addition, 3 motor patrols were used to cover secondary roads. Following a release of that part of Florida lying between the Ocklockonee River and the Aucilla River, stations located along the Ocklockonee were removed to highways crossing the Aucilla. From August, 1929, when an eradication area within the regulated area was defined, until July 30, 1930, when the State plant board released this area, 2 additional border patrols were maintained by the State plant board—1 on the north and 1 on the south boundary of the eradication area.

A detailed statement of the numbers of vehicles inspected and intercepted is given in Table 3.

TABLE 3.—*Summary of inspection, under Mediterranean fruit-fly quarantine, of vehicles and baggage leaving the eradication area, July 1 to November 15, 1930*¹

Month	Georgia-Florida border patrol		Ocklockonee River patrol		Aucilla River patrol ²	
	Vehicles inspected	Vehicles in which fruit was found	Vehicles inspected	Vehicles in which fruit was found	Vehicles inspected	Vehicles in which fruit was found
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
July.....	56, 889	2, 077	27, 477	1, 216	-----	-----
August.....	62, 096	5, 215	28, 479	1, 964	-----	-----
September.....	44, 916	2, 854	23, 082	1, 280	-----	-----
October.....	38, 207	2, 577	11, 426	502	6, 220	541
November ²	12, 332	814	-----	-----	5, 279	450
December ²	-----	-----	-----	-----	-----	-----
Total.....	214, 440	13, 537	90, 464	4, 962	11, 499	991

¹ Similar information for the fiscal years 1929 and 1930 is given in the Service and Regulatory Announcements of the administration, No. 99, p. 53; No. 101, p. 188; and No. 103, p. 37.

² The western boundary of the regulated area was changed from the Ocklockonee River to the Aucilla River, effective Oct. 15, 1930. All stations were discontinued when the quarantine was lifted on Nov. 15.

TRANSFER OF PROPERTY

All field activities were discontinued on March 31, 1931. Intensive effort was required in order to complete field records, dispose of supplies and equipment, and close the project before the end of the fiscal year.

Original records were shipped to Washington for permanent files. The supplies and equipment transferred to other projects of the administration represented 42 car lots, 62 less-than-car lots, and 2 lots driven away, with a total value of \$215,085.29. Those transferred to other bureaus of the United States Department of Agriculture represented 25 car lots, 77 less-than-car lots, and 55 lots driven away, with a total value of \$132,870.63. Those to other departments of the Government, transferred through the Chief Coordinator, represented 31 car lots and 14 less-than-car lots, with a total value of \$91,565.42. Included in the surplus equipment aforementioned was certain surplus European corn borer equipment valued at \$187,827 that had been transferred from the European corn borer project to the Mediterranean fruit fly eradication project in Florida.

The remaining serviceable property, for which there was no demand by Government agencies, was surveyed and sold in 26 lots, bringing a total of \$9,188.73. Articles of no value or further service, costing \$370.20, were surveyed and destroyed.

GIPSY MOTH AND BROWN-TAIL MOTH

CONDITIONS OF GIPSY-MOTH INFESTATION IN NEW ENGLAND

During the summer of 1930 the extent of defoliation by the gipsy moth showed a considerable decrease. The total area reported as stripped aggregated 288,225 acres, only a little more than half that recorded during the previous year. In a little less than half of this acreage, defoliation ran 10 per cent or less. In Massachusetts and

New Hampshire there was a marked decrease in the acreage defoliated but in Maine the increase was about threefold.

EXTERMINATION WORK IN NEW JERSEY

The last gipsy-moth infestation in New Jersey was found in May, 1929, and the area was thoroughly scouted, sprayed, and followed up by close patrol work. Since that time very intensive work has been carried on around all the infestations found in previous years. The southern half of Bridgewater Township and the northern half of Hillsboro Township have been examined with special care, as this area was the most heavily infested when the insect was first found in New Jersey. The work done thus far has failed to reveal any trace of the gipsy moth during the past year and no spraying was necessary in the spring of 1931. Further scouting and check-up work will be required in these two townships during the next fiscal year, but the volume of work will be very materially reduced and if no infestation develops only a relatively small amount of scouting and patrol work will be necessary for a few years in the future.

The area in New Jersey infested with the gipsy moth has been maintained under a State quarantine enforced by agents of this administration, working cooperatively with the State. As the infested area decreased, the limits of the quarantine were reduced until at the present time only two townships are affected by the regulations. During the fiscal year 1931, 1,208 shipments of nursery stock and forest products originating in these townships have been inspected and certified before they were moved.

The work in New Jersey has been carried on by this administration in cooperation with the New Jersey Department of Agriculture, the project being handled by the Federal force and the expense shared by both organizations. The progress made has been very satisfactory and only a relatively small amount of work is now required in order to close up the work in that State and release the remaining townships from quarantine.

GIPSY-MOTH WORK ON LONG ISLAND

Since the beginning of the last fiscal year the clean-up and extermination work on Long Island has been managed by the conservation department of the State of New York. Intensive scouting has been carried on in the area originally infested, centering around North Roslyn. In addition to this area portions of the towns of Hempstead and Oyster Bay and the entire town of Huntington, together with a small area in the northwestern part of Babylon, have been scouted. Some additional work has also been done in Southold, Brookhaven, Islip, and the Borough of Queens. No infestation of the gipsy moth was found by the conservation department as a result of this work, except in the towns of North Hempstead and Oyster Bay. In the former, 110 egg clusters were discovered in 17 infested localities, and in the latter, 67 were found in 24 infested localities. Practically all of these infestations were found in woodland, and intensive spraying was carried on during May and June for the purpose of cleaning up these scattered areas.

After the gipsy-moth infestation was found on Long Island a State quarantine was declared restricting plant shipments from

points within a radius of 3 miles from North Roslyn to points outside. All plant material was inspected by agents of this administration and certified as free from the gipsy moth before movement was permitted. On account of the marked reduction in the infestation found in this area during the past winter and the fact that all infested points were well within a radius of 2 miles from the point of original infestation, the quarantine was modified in the spring of 1931, releasing the territory beyond the 2-mile radius from the requirement that inspection and certification must be made at the time of shipment. This arrangement was worked out in cooperation with the department of conservation and the department of agriculture and markets of the State of New York.

During the fiscal year 1931, 4,033 shipments of nursery stock were thoroughly inspected and certified before they were permitted to move beyond the quarantined area.

Substantial progress has been made in handling this infestation, and it is believed that another season's work will show a considerable reduction in the number of locations where the insect is present.

BARRIER-ZONE PROJECT IN NEW ENGLAND AND NEW YORK

Work on this project has been continued throughout the fiscal year, the conservation department of the State of New York handling most of the territory in that State and the Federal force confining its efforts to the New England section of the zone. In line with the policy adopted last year, special attention has been paid to scouting woodland areas as it was believed that infestations of considerable size might exist in them and cause continued reinfestation of territory that was being cleaned up.

The barrier-zone area in New England and in New York State north of the town of Dresden embraces nearly 2,000,000 acres of woodland, and at the close of the fiscal year 1930 over 638,000 acres of this had been scouted. During the fiscal year 1931, 443,000 acres were scouted, leaving a balance of about 900,000 acres which requires attention during the next two fiscal years. The area in the New York section of the barrier zone south of Dresden is not so heavily wooded, but covers approximately a million acres. Large sections of this territory have already been scouted by the New York conservation department, and special attention is being paid at the present time to those portions of the territory where gipsy-moth infestations have been located in previous years and where clean-up work has been carried on.

In addition to the woodland scouting carried on by the Federal force, intensive scouting has been done in the towns that heretofore have been found infested by this insect. These embrace groups of towns in southwestern Massachusetts and northwestern Connecticut.

The result of this work shows somewhat fewer infestations than during the previous fiscal year and indicates that marked progress has been made in cleaning up infested locations. Table 4 gives a summary of the infested locations found during the fiscal years 1930 and 1931.

TABLE 4.—*Gipsy-moth infested locations found in the barrier zone, fiscal years 1930 and 1931*

State and town	1930	1931	State and town	1930	1931
Massachusetts:			Connecticut—Continued		
Becket.....	2	0	Salisbury.....	6	² 5
Monterey.....	1	0	Sharon.....	2	0
Mount Washington.....	1	0	Wallingford.....	3	1
New Marlboro.....	42	¹ 38	Warren.....	3	1
Otis.....	2	0	Washington.....	(³)	1
Sandisfield.....	15	10	New York: ⁴		
Sheffield.....	17	13	Dover.....	1	0
Stockbridge.....	1	1	Hillsdale.....	1	1
Connecticut:			Milan.....	(³)	2
Beacon Falls.....	1	0	Rhinebeck.....	(³)	1
Canaan.....	12	10	Taghkanick.....	1	0
Cornwall.....	3	1			
Norfolk.....	5	1	Total.....	120	86
North Canaan.....	1	0			

¹ Two of these infestations were larval colonies.² One of these infestations was a larval colony.³ No scouting done.⁴ Work in New York carried out by the New York State Department of Conservation; other barrier-zone surveys, by the Plant Quarantine and Control Administration.

During the past year no infestation was found in the barrier-zone area in Vermont in the scouted territory. This embraced all the towns in the zone from Manchester, Vt., to the Massachusetts line, also a group of towns northwest of Rutland. Most of the Vermont territory examined is heavily wooded, rough and mountainous in character, and is by far the most difficult that has been scouted for gipsy-moth infestation. Fortunately weather conditions in the late summer and early fall were very favorable for this work and progress was more rapid than was at first anticipated. Woodland-scouting work in Massachusetts was pushed during the year and all of the territory in the zone in that State has now been scouted at least once. In Connecticut the woodland in that part of the zone located in Litchfield County has been covered, as well as eight towns in New Haven County and three towns in Fairfield County. Early in July, 1931, a scattered infestation was found in Colebrook, Conn., near the Massachusetts State line. A group of towns including Sandisfield and New Marlboro, Mass., and North Canaan, Canaan, and Norfolk, Conn., have carried numerous infestations, many of them in woodland, during the last two years.

It is entirely probable that similar conditions exist in other towns east of the barrier zone and the presence of such colonies would doubtless explain the difficulty that is being experienced in keeping the towns just mentioned free from more or less continuous infestation. Work in towns east of the zone is greatly needed in order to give the zone itself satisfactory protection from further infestation.

Records from weather stations at Shelburne and Westfield, Mass., indicate that the number of hours in 1930 when temperature and wind velocity were favorable for westward spread of this insect immediately after hatching, exceeded the same record for the years 1928 and 1929, and emphasize the importance of finding and cleaning up isolated colonies east of the zone without delay.

The character of the territory in which infestations were found during the present year necessitated more chopping and brush removal than usual.

Spraying equipment was ready for operation and was placed in the field June 2, the treatment work being completed July 11, 1931. Very unfavorable weather was encountered during the first part of this period, but later on better conditions prevailed. Thirty high-power spraying machines were operated in the infested towns in Massachusetts and Connecticut and all infestations were thoroughly sprayed. Two machines were also furnished for spraying in the barrier zone in Rhinebeck, Milan, and Hillsdale, N. Y., and four machines were loaned to the conservation department of New York for use in the gipsy-moth infested area near North Roslyn, Long Island.

Most of the territory sprayed was in rather dense growth in semi-mountainous country. Frequently more than 6,000 feet of hose was required in order to reach the location where the spray had to be applied. The ground was steep, which made the operations especially difficult. At the close of the spraying season, 3,768 acres had been treated. Continued intensive scouting work will be required in these towns in order to take advantage of the progress that has been made.

As an adjunct to scouting, 853 cages for attracting male moths were set up and patrolled in 26 towns in New Jersey, 287 in Connecticut, 377 in Massachusetts, and 14 in New York. Except in the New Jersey area, all cages were placed in towns where infestation had been found in the barrier zone. No male moths were caught at any of the cages in the New Jersey area. A single male moth was taken at one of the cages in Hillsdale, N. Y., and two males were taken at each of two different cages located in the town of New Marlboro, Mass. At all the other cages results were negative.

In order to secure material from which to make extracts for these cages, extensive collections of female gipsy-moth pupae were made in July, 1930, in the vicinity of Manchester and Hookset, N. H., and near Middleboro, Mass. In making the extracts the tips of the abdomens of live female moths are clipped into some solvent, ordinarily xylene or benzol. Small quantities of these extracts are exposed in the cages to attract the male moths.

Incidental to the handling of female pupae to secure the moths from which the extract is obtained, a considerable number of one of the imported Tachinid flies that attacks the gipsy moth have been collected. This species, known as *Sturmia scutellata*, when in the maggot form, feeds within and then emerges from the gipsy-moth pupae. After they emerge from the pupae the maggots are allowed to drop into boxes containing leaf mold and in this way some 35,000 were secured and were liberated in territory immediately east of the barrier zone in New England. They were placed in selected locations in 5 towns in Vermont, 22 towns in Massachusetts, and 5 towns in Connecticut. Mortality of these parasites is doubtless rather heavy during the winter, but the survivors have opportunity to emerge in the spring and attack gipsy-moth caterpillars that may be feeding in the immediate vicinity.

QUARANTINE AND INSPECTION WORK

The number of bulk shipments requiring inspection during the fiscal year has not averaged quite as large as that of the preceding year, but there has been a marked increase in the number of small lots, so that

the amount of work required properly to inspect and certify the material moving from the area under quarantine has increased considerably.

The proper inspection of Christmas trees and greenery during November and December necessitated the utilization of a large number of agents who were transferred temporarily from the scouting force. During the spring and fall nursery season the calls for the inspection of small lots were more numerous than usual and additional men to care for this work were also supplied from the scouting force. Tables 5 to 7 indicate the volume and kind of products inspected and certified during the year.

TABLE 5.—*Evergreen products certified under gipsy-moth quarantine, fiscal year 1931*

Material	Bags	Bales	Boxes	Bundles	Carloads	Packages	Trees	Truck loads
Balsam twigs.....	499	25	44					
Boughs.....	2	10, 015	14	484	64			2
Christmas trees.....				3, 334	667		66, 502	
Cut cedar trees.....							81	
Laurel.....	932	354	246	3, 175	1	12		2
Mixed greens.....	111	21	5, 730	132		191		
Wreaths.....			14					
Total.....	1, 544	10, 415	6, 048	7, 125	732	203	66, 583	4

Nursery stock certified under the gipsy-moth quarantine during the fiscal year 1931 consisted of 7,949 bales, 10,626 boxes, 259 carloads, 5,376 cases, 210 cash-and-carry packages, 16,457 packages, and 2,246 truck loads.

TABLE 6.—*Forest products certified under gipsy-moth quarantine, fiscal year 1931*

Material	Bags	Barge loads	Boxes	Bundles	Carloads	Cases	Cords	Lots	Pieces	Truck loads	Found infested	Gipsy moths found	
												Egg clusters	Larvae and pupae
Barrel parts.....				1, 139	62								
Crates and cratings.....					6				480				
Fuel wood.....	30		5		71	1	179			12	10 bags 1 car 5 cords 1 truck	40	
Logs.....					231				156	33	1 car 1 piece 7 barges	3	
Lumber.....		9		193	545			179	39	155	3 cars 1 lot	141	36
Piles and poles.....					236				587	37			
Posts.....				62	8				1, 762				
Pulpwood.....					4, 316		1, 750		5	1, 279			
Reels.....					487			13	9, 008	13	6 cars	32	29
Shavings.....					51								
Ship knees.....					3				414				
Spool stock.....					97								
Ties.....					1, 835				1				
Shrub and vine cuttings.....	1		259	71									
Miscellaneous.....	88	1	59	2, 059	106	19		22	11, 600	40	1 barge 4 cars 25 pieces	107	
Total.....	119	10	323	3, 524	8, 054	20	1, 929	214	24, 052	1, 569	(1)	323	65

¹ Infested total: 10 bags, 8 barges, 15 cars, 5 cords, 1 lot, 26 pieces, 1 truck.

² Includes 14 larvae and 51 pupae.

TABLE 7.—*Stone and quarry products certified under gipsy-moth quarantine, fiscal year 1931*

Material	Bags	Barge loads	Barrels	Boxes	Car-loads	Crates	Pieces	Truck loads	Found infested (car-loads)	Gipsy moths found	
										Egg clusters	Larvae and pupae
Crushed rock.....	20	6	-----	3	1,773	-----	-----	10	-----	-----	-----
Curbing.....	-----	1	-----	7	364	-----	100	-----	2	2	-----
Feldspar.....	1	-----	-----	5	110	-----	-----	-----	-----	-----	-----
Granite.....	-----	46	-----	90	5,396	612	161,314	11	6	110	-----
Grout.....	-----	-----	-----	-----	97	4	-----	-----	-----	-----	-----
Marble.....	2	-----	13	26,599	1,379	49,041	10,217	-----	-----	-----	-----
Paving.....	-----	18	-----	32	944	-----	5	-----	36	154	5
Miscellaneous.....	102	-----	1	5	43	-----	6	-----	-----	-----	-----
Total.....	125	71	14	26,741	10,106	49,657	171,642	21	44	166	5

¹ This does not include 56 egg clusters found on car stakes and crating material.

The material shown in Table 8 originated outside the gipsy-moth quarantined area and was shipped from points inside the area under authorized permits.

TABLE 8.—*Shipments under permit from inside the quarantined area of articles that originated outside of that area, gipsy-moth quarantine, fiscal year 1931*

EVERGREEN PRODUCTS

Material	Bags	Bales	Barrels	Boxes	Bundles	Cars	Cases	Trees
Balsam twigs.....	11	-----	-----	-----	-----	-----	-----	-----
Boxwood.....	16	-----	1	30	10	-----	46	-----
Boughs.....	-----	-----	-----	-----	1	3	-----	-----
Christmas trees.....	-----	-----	-----	-----	-----	102	-----	2,215
Holly.....	-----	-----	-----	11	5	-----	62	-----
Huckleberry.....	1	6	-----	37	117	-----	-----	-----
Laurel.....	23	-----	1	33	514	-----	1	-----
Mixed greens.....	-----	-----	-----	25	12	-----	1	-----
Total.....	51	6	2	136	659	105	110	2,215

FOREST PRODUCTS

Material	Bundles	Car-loads	Cases	Cords	Lots	Pieces	Truck loads	Wagon loads
Fuel wood.....	-----	4	-----	36	-----	-----	25	5
Logs.....	-----	-----	-----	-----	-----	279,361	56	1,097
Lumber.....	-----	115	-----	-----	3	-----	29	-----
Poles.....	-----	25	-----	-----	-----	-----	-----	-----
Pulpwood.....	-----	109	-----	45,884	-----	-----	-----	-----
Spool stock.....	-----	1	-----	-----	2	-----	-----	-----
Ties.....	-----	5	-----	-----	-----	-----	-----	-----
Vine and shrub cuttings.....	-----	-----	11	-----	-----	-----	-----	-----
Miscellaneous.....	25	15	-----	-----	-----	4	5	42
Total.....	25	274	11	45,920	5	279,365	115	1,144

NURSERY STOCK

Material	Bales	Boxes	Cases	Packages
Nursery stock.....	146	13	41	5

TABLE 8.—*Shipments under permit from inside the quarantined area of articles that originated outside of that area, gipsy-moth quarantine, fiscal year 1931—Continued*

STONE AND QUARRY PRODUCTS

Material	Boxes	Carloads	Crates	Pieces
Granite.....		3		35
Marble.....	31	6	22	1
Total.....	31	9	22	36

Under the gipsy-moth quarantine regulations materials that have been manufactured, processed, and stored in such a manner that in the judgment of the inspector no infestation could be transmitted, may be moved if accompanied with permits issued to the shipper.

TABLE 9.—*Shipments under permit of articles manufactured, processed, and stored in such manner that no infestation could be transmitted, fiscal year 1931*

Material	Firms shipping ¹	Barge loads	Carloads	Disks	Lots	Pieces	Reels	Tons
Forest products.....	50		1,031	270	1,367		3,536	
Stone and quarry products.....	71	88	1,425			16,683		94,176
Total.....	121	88	2,456	270	1,367	16,683	3,536	94,176

¹ Firms under permit at the close of the last fiscal year, 120; permits canceled during the fiscal year 1931, 5; permits granted, 6.

The inspectors have been instructed to utilize time not required for regular inspection and certification work in examining tourist camps for gipsy-moth or brown-tail moth infestation. The reports on this work cover 55 camps. Small gipsy-moth infestations were found on trees in one camp in Massachusetts and in three camps in Maine. In one Maine camp three brown-tail moth webs were discovered. In all cases the proprietors were given instructions concerning the proper methods to be used in cleaning up the infestation. The States concerned were also notified.

There has been a radical change in the tourist camps during the last few years. Not only have the owners shown more interest in cleaning up the property and keeping it in a more attractive condition, but many camps in wooded areas have been abandoned. Overnight camps of the cabin type are now more commonly used. They are generally located in open fields. This has decreased the chances of spreading injurious insects by means of tourist travel.

VIOLATIONS

During the fiscal year investigations were made of 442 violations of the gipsy-moth and brown-tail moth quarantine (No. 45) and of 60 reported violations of other quarantines effective in the New England territory. Nearly all of these were noncommercial shipments by parties who through ignorance or incorrect information had failed to comply with some of the requirements of the regulations. About 70 per cent were small shipments by mail, and in no case was evidence secured of willful intent to evade the requirements of the quarantines

concerned. Personal contact with the parties and careful explanation of the requirements will, it is believed, result in correcting violations.

COOPERATION

This division has cooperated with all the States concerned in quarantine and control work within its field and has given such assistance as possible to other activities of the administration and to other bureaus of the department.

THE BROWN-TAIL MOTH

The territory infested with this insect has not increased during the past year. In the summer of 1930, however, more defoliation than usual was reported, particularly in New Hampshire and Maine. During the early winter the hibernating webs were far more abundant than usual, and a special effort was made by the States concerned to cut and destroy them before the larvae emerged in the spring. Reports received from State and local officials in Maine, New Hampshire, and Massachusetts indicate that nearly 2,000,000 webs were cut and burned during the winter. In spite of this a considerable amount of defoliation occurred in June, 1931, and annual inspection and destruction of webs will be necessary to prevent continued and increased damage by this insect.

REVISION OF REGULATIONS

A revision of the gipsy-moth and brown-tail-moth quarantine regulations was made effective June 1, 1931. No new territory was added, but the regulations were altered along the lines of some of the more recent quarantines. Certain classes of products were more clearly defined and the procedure changed in order to prevent any unnecessary restrictions on materials that could be moved without danger of spreading the pests.

THE SATIN MOTH

The satin moth continued to spread during the summer of 1930, making it necessary to place additional territory under quarantine. On February 1, 1931, 6,713 square miles in Maine, 880 in New Hampshire, 307 in Vermont, 640 in Massachusetts, and 857 in Connecticut, a total of 9,397 square miles, embracing 267 towns or independent units, were added to the regulated areas.

The amount of defoliation in June, 1931, was less than during the previous year, partly because of migration from densely infested areas and the effectiveness of spraying in many sections. In certain areas there was a rather heavy mortality of the hibernating larvae during the winter.

EUROPEAN CORN BORER

European corn borer and Japanese beetle quarantine and control activities of the administration were consolidated during the past year. Combining the field work on the two projects under one directing head made practicable certain notable economies in both administration and operation. Greater utilization of experienced inspectors, made possible by joining the two undertakings, has already increased efficiency and will further increase it in the future. Elimination of much of the duplicated effort, especially in inspection of farm products and maintenance of quarantine line highway stations

in areas under regulation on account of both pests, is of major importance in assuring greater convenience to the public.

General headquarters were established at South Norwalk, Conn. Here there has been gradually collected the personnel and equipment for most of the administrative functioning previously centered at Boston, Mass., and Toledo, Ohio, for corn-borer control, and at Camden, N. J., for the Japanese beetle. Field work in corn-borer control continues to be closely supervised from three area subheadquarters—eastern, at Boston, Mass., central, at South Norwalk, Conn., and western, at Springfield, Ohio. Japanese-beetle matters also are given supervision, in the territories under quarantine on account of this pest, from the eastern and central area offices. A separate division supervises the Japanese-beetle activities in sections where there are infestations of this pest only.

The Plant Quarantine and Control Administration continued to receive cooperation from the Bureaus of Entomology and Public Roads. Findings at the various research stations of the former bureau assisted in a better understanding of the life history and habits of the pests, on which understanding must depend in large part the administration's control and regulatory work. The agricultural engineers of the Bureau of Public Roads carried further their experiments in improvement of mechanical devices for corn-borer control, the vital importance of which has been increasingly apparent. Special study was devoted to modifications of attachments and implements, to make them more efficient under the peculiar conditions existing in New England and other eastern regions, with results that hold much promise.

CORN-BORER SPREAD

The drought of the summer and fall of 1930 affected both crop yields and the reproduction of the European corn borer. In those infested regions suffering most from the drought there was a decline in the population of the pest.

However, while the general spread of the borer was less than normal, more isolated infestations were found in 1930 than in any preceding year. The borer was found for the first time at seven points from which it could spread to surrounding regions that in the normal advance of the pest would not have been reached until later. Five of these new isolated infestations were in the 1-generation area, in Bracken and Lewis Counties, Ky., and in Adams and Clermont Counties, Ohio. Two were in the 2-generation area, in Fairfield County, Conn., and Essex County, N. J. The Ohio and Kentucky centers were on bottom lands along the lower Ohio River or on islands in the river and probably originated from debris carried down streams from infested fields.

In the 1-generation area there were reductions averaging approximately 25 per cent in the number of borers found in representative sample plots in New York, Pennsylvania, Ohio, Indiana, and Michigan. The surveys indicated decreases of about 21 per cent in Michigan, 29 per cent in Pennsylvania, and 58 per cent in Ohio. Increases approximated 11 per cent in New York and 33 per cent in Indiana. Distinct increases also were registered in certain counties of some of the States showing general decreases. Lenawee, Macomb, and Oakland Counties, in Michigan, and Defiance, Henry, and Wil-

liams Counties, in Ohio, were outstanding examples of such increased borer population.

Equivalent reductions in the intensity of infestation were recorded in the 2-generation area, now composed of the central-eastern part of New England and portions of southern New York and northeastern New Jersey. Though the severe drought did not extend to this region, the more heavily infested sections, in eastern Massachusetts and Rhode Island, have been subjected to intensive suppressive operations which appear to have proved effective. In the eastern part of Long Island where the 2-generation strain is established a similar trend toward lessening of population was observed. Exceptions to the prevailing reductions were noted in three eastern Massachusetts counties, Bristol, having an increase of from 230.5 to 261.1 borers per 100 plants; Middlesex, an increase of from 259.5 to 265.3, and Norfolk, an increase of from 225.7 to 484.5.

Spread of the corn borer westward and southward into new localities was less extensive in 1930 than it had been in the years immediately preceding. Only a narrow belt of new territory in Indiana and Ohio was found to be infested with the 1-generation strain. Advance of the pest was more extensive in West Virginia, where it reached parts of seven counties not before known to be infested. On the eastern border of the 1-generation area it was found that the borer had crossed the upper Delaware River from Pennsylvania into two counties of New Jersey. Extension of the 2-generation form of the pest was more serious, it having been found to have moved southwestward in Connecticut and on Long Island. Movement northeastward in Maine likewise was found to have taken place in such degree as considerably to increase the infested area in the southern part of the State. Danger of spread by debris drifting down stream was again emphasized by the discovery of the infestations on the Ohio River previously mentioned. In the late summer supplies of manure found going from Long Island to the mushroom-growing region west of Philadelphia, presented another instance of conditions favorable to the long-distance spread of the 2-generation strain. Special surveys accordingly were made in Chester County, Pa., where the borer might have become established from this source, but no infestations were found.

COOPERATIVE CLEAN-UP WORK

Compulsory clean-up of crop remnants and debris again was enforced by State authorities in Maine, Massachusetts, Rhode Island, Connecticut, and parts of Pennsylvania. All these States except Pennsylvania are in the area infested by the 2-generation strain of the borer. As farmers, florists, and truck growers better understand the damage that the pest will do if not kept under control, their cooperation in this feature of the undertaking is more and more efficient.

Even in the 1-generation area, the clean-up operations were carried out by farm owners and lessees in a gratifyingly large number of instances. Inspectors for the Pennsylvania Department of Agriculture, which is cooperating in the matter with the Plant Quarantine and Control Administration, visited 6,863 farms, on 4,958 of which it was found that all corn stubble had been plowed under in a satisfactory manner and all refuse and remnants cleaned up. Of 21,369 acres inspected, it was necessary for the State authorities to clean

only $36\frac{7}{12}$ acres. In addition, $43\frac{1}{2}$ hours of labor were devoted to premises from which some stubble and other material remained to be removed. Total cost of the clean-up done by the inspection force, involving 12 separate cases, was only \$171.05.

An isolated infestation outside of the regulated area in Danbury, Conn., was cleaned up in cooperation with the State Agricultural Experiment Station. In burning the débris over 7 acres of land, 1,400 gallons of kerosene were consumed, the total cost having been \$264.67. Owing to the large decrease in infestation in Brooklyn and on Staten Island, clean-up work previously done was not repeated. Isolated infestation in Upper Montclair, N. J., led to destruction by the growers of all vegetable débris within a radius of some 3 miles. Rescuing of the premises in September, 1930, and an investigation in the spring of 1931, failed to disclose continued presence of the pest and further clean-up by the quarantine agencies was regarded as unnecessary.

Some of the Central Western States infested with the 1-generation strain of the corn borer lack clean-up laws while in others having such statutes enforcement is not general. Only in certain localities where there has been considerable crop damage are farmers inclined to incur the expense of removing débris, yet this situation showed some evidence of improvement in 1930-31. Special clean-up activities of the administration in the western area, applied to isolated infestations, were concentrated in four localities in Adams and Clermont Counties, Ohio, and Bracken and Lewis Counties, Ky. In the two Ohio counties, approximately 50 acres of cornland was plowed, and crop remnants burned. Six barn and feed lots also had attention. An island in the Ohio River on the Kentucky side having about 80 acres of cornland, and some 260 acres of Kentucky mainland were given similar treatment. Fodder transported several miles from the farms on which it had been grown was traced and destroyed.

SCOUTING TO DETERMINE SPREAD

Scouting to determine the spread of infestation continued in territory adjacent to the areas already under quarantine.

In Maine this field inspection covered 74 townships, extending from the New Hampshire line to the Canadian border. New infestations of the 2-generation strain were found in Penobscot and Washington Counties. Additional infestations were also discovered in certain townships of three counties—Androscoggin, Kennebec, and Waldo, which had been infested previously.

Eighteen Massachusetts towns, comprising the heretofore unregulated section west of Worcester County, were scouted, and new infestations of 2-generation borers were found in Hampden and Hampshire Counties.

Pennsylvania was scouted by 20 crews, 10 working west and 10 east of the Susquehanna River, and New Jersey by 20 crews, 10 of which were transferred to Connecticut and 3 to New York later in the summer. Altogether, a total of 11 townships in Pennsylvania not before known to contain the pest were found infested.

Farther west, along the borders of the quarantined territory, 167 crews scouted in West Virginia, Ohio, Kentucky, Indiana, Illinois, Michigan, Wisconsin, and Missouri. An aggregate of 602 townships scouted showed more than 10 per cent, or 70, to be infested. Twenty-

one scouts were paid from State funds, through the cooperation of Illinois, Missouri, and Wisconsin.

Two schools were conducted to prepare scouts for efficient and diplomatic field work. That at Schenectady, N. Y., in session for one week, was attended by 88 scouts. Due to the greater amount of territory to be covered, 394 attended the school for the western area, at Toledo, Ohio, which ran for 11 days. Instructions were given in every phase of scouting, including methods, map reading, reports, collection of specimens, care of trucks, personal conduct, etc.

A synopsis of scouting results is given in Table 10.

TABLE 10.—*European corn-borer infestation record, 1930*

State	Townships found infested	Townships found not infested	Area under quarantine at end of the 1930 scouting season in—	
			1-generation area	2-generation area
	<i>Number</i>	<i>Number</i>	<i>Square miles</i>	<i>Square miles</i>
Connecticut.....	46	57	421.54	3,610.25
Delaware.....		7		
Illinois.....		69		
Indiana.....	16	163	13,938	
Kentucky.....	3	29		
Maine.....	11	63		3,829.49
Maryland.....		24		
Massachusetts.....	5	13	1,595.80	6,511.37
Michigan.....	21	15	57,980	
Missouri.....		5		
New Hampshire.....				9,031
New Jersey.....	8	285	1.85	39.89
New York.....		25	44,173	2,085
Ohio.....	24	121	35,713	
Pennsylvania.....	11	166	28,337.35	
Rhode Island.....				1,248
Vermont.....			4,912.90	
West Virginia.....	6	81	2,678	
Wisconsin.....		54		
Total.....	151	1,177	189,751.44	26,355

¹ Scouting in Missouri was in river bottom lands between the Mississippi River and the dyke, along the entire border of Mississippi County.

QUARANTINE LINE VEHICLE INSPECTION STATIONS

Maintenance of vehicle inspection on highways along the boundaries of the quarantined areas again demonstrated its usefulness, both in direct detection of prohibited products and indirectly by lessening the tendency to attempt violations of the regulations.

In Massachusetts, quarantine-line stations were located on the west border of Worcester County. Of approximately 100 stations in the central territory, 34 were in the 2-generation area of Connecticut. On the western and southern edges of the 1-generation area, 109 road stations and 20 port stations were in use during the summer period, requiring 499 inspectors.

Particular attention was paid to bridges and ferries across the Ohio River. Effects of the drought on the Kentucky corn crop largely increased the demand for ear corn from both Indiana and Ohio. Between Huntingdon, W. Va., and Louisville, Ky., nine bridges were under inspection from January 9 to April 15, 1931, and 24 ferries were patrolled by a flexible force during the same period.

Reactions of the public to the enforcement of the quarantine, as evidenced in its behavior at highway stations, generally showed a

greater disposition to cooperate and less tendency to resist. In nearly all cases of refusal to stop for inspection, drivers appear to be under a misapprehension or to lack any information. Whenever the facts as to the pest and the purpose of the regulations can be explained, a more friendly spirit generally results.

Details of the vehicle inspection work follow:

	Number
Quarantine stations.....	208
Ports of inspection.....	20
Vehicles stopped.....	15, 568, 924
Ears of corn taken.....	334, 292
Passengers inspected at steamship lines.....	56, 985

SURVEYS OF BORER POPULATION

Intensive survey work again was conducted by the eastern area division of corn-borer control in cooperation with the Massachusetts Department of Agriculture, covering the market-garden districts surrounding Boston, infested with the 2-generation strain. Continued improvement over the conditions of previous years was developed, and local officials were found interested and desiring to help.

Infestation surveys in the Lake States area and eastern New York were conducted for about one month, beginning August 18, 1930. Members of this special scouting force had been given a course of intensive training at the department farm near Toledo, Ohio, before beginning the field work. Each man covered a district including several counties and a total of 126 counties in five States were scouted.

A particularly gratifying feature of this year's infestation survey was the cooperative and friendly attitude of farmers whose permission for entry upon their premises was asked. Not a single refusal was encountered in either New York or Pennsylvania, and in Ohio, Michigan, and Indiana together only six farm owners declined to grant the inspectors access to their properties.

Surveys were made as a check against the regular infestation surveys in four counties of Michigan and five of Ohio, in the 1-generation area. Three 2-man crews were called in from scouting for this work, which commenced on August 25 and was completed by September 15.

DÉBRIS AND EGG SURVEYS

Débris surveys were carried on in selected areas of New York, Pennsylvania, Ohio, and Michigan, beginning early in May, 1931, and ending before the middle of June. Splendid cooperation was given by farmers in granting permission for the inspectors to enter the grainfields for this work. Counts were made in 1,445 fields in 34 counties of the four States.

The county was taken as the unit in the egg survey, except in a few cases, where several counties were combined. This activity extended over about 20 units in the same group of four States covered in the débris survey. Egg counts were made in 30 fields in each unit, as a rule. Thirty plants were examined, and 10 plants measured in each of 10 fields every day. It required, therefore, three days to make the round of the fields in each unit.

Table 11 summarizes a study of larval survival and the potentiality of borers allowed to remain in the débris. In Table 12 is presented a total of egg masses deposited.

TABLE 11.—*A study of larval survival and the potentiality of borers allowed to remain in the debris—1930*

State and county	Borers per acre in growing corn, fall, 1929	Borers per acre remaining in debris, spring, 1930	Eggs laid per acre, spring, 1930	Relative value of 1 borer in terms of eggs laid ¹	Borers per acre surviving in growing corn, fall, 1930	Survival	Net production of borers for each borer in the debris	Net production of borers in 1930 for each borer in the corn of 1929
Michigan:	<i>Number</i>	<i>Number</i>	<i>Number</i>		<i>Number</i>	<i>Per cent</i>	<i>Number</i>	<i>Number</i>
Lapeer.....	2,023		26,489		1,489	5.62		0.74
Lenawee.....	1,468	35.56	187,032	5,260	2,918	1.56	82.1	1.99
Macomb.....	2,667	76.16	102,618	1,347	3,574	3.48	46.9	1.34
Monroe.....	7,795	188.40	177,190	940	1,284	.72	6.8	.16
Oakland.....	2,331	56.47	156,631	2,774	3,261	2.08	57.7	1.40
Ohio:								
Ashtabula.....	1,088	5.08	40,370	7,947	106	.26	20.9	.10
Erie.....	3,274	279.40	198,671	711	1,012	.51	3.6	.31
Fulton.....	1,678	248.00	171,656	692	1,345	.78	5.4	.80
Hancock.....	1,526	90.32	60,484	670	745	1.23	8.2	.49
Lucas.....	13,397	234.20	84,381	360	2,632	3.12	11.2	.20
Ottawa.....	9,903	82.90	127,900	1,543	3,884	3.04	46.9	.39
Seneca.....	2,658	114.30	60,643	531	467	.77	4.1	.18
Wood.....	4,675	116.50	131,541	790	674	.51	5.8	.14
Pennsylvania: Erie..	1,290	35.20	17,617	500	495	2.81	14.1	.38
New York:								
Albany area.....	1,914	274.20	116,849	426	381	.33	1.4	.20
Chautauqua.....	3,716	35.56	14,549	409	1,632	11.22	45.9	.44
Fulton.....	4,226	185.40	83,714	452	1,245	1.49	6.7	.29
Niagara.....	2,165	68.60	96,227	1,403	4,974	5.17	72.5	2.30
Oswego.....	1,442	72.38	91,489	1,264	2,303	2.52	31.8	1.60

¹ The figures in this column are only relative in value. They illustrate, however, the possibilities of borers remaining in the corn debris together with the influx of moths from other sources in the presence of favorable conditions for egg laying.

TABLE 12.—*Total egg masses deposited—1930*

State and county	Total egg masses per 100 plants in county	Total egg masses per acre in county	State and county	Total egg masses per 100 plants in county	Total egg masses per acre in county
Michigan:			Ohio—Continued		
Lapeer.....	18.21	1,666.22	Ottawa.....	87.91	8,043.77
Lenawee.....	123.56	11,763.24	Seneca.....	41.68	3,813.72
Macomb.....	70.53	6,453.50	Wood.....	90.42	8,273.43
Monroe.....	121.80	11,144.70	Pennsylvania: Erie..	12.11	1,108.07
Oakland.....	107.67	9,851.81	New York:		
Ohio:			Albany, Schenectady,		
Ashtabula.....	27.75	2,539.13	Saratoga, Rensselaer..	80.32	7,349.28
Erie.....	136.56	12,495.24	Chautauqua.....	10.00	915.00
Fulton.....	117.99	10,796.09	Fulton, Montgomery...	57.55	5,265.83
Hancock.....	41.57	3,803.66	Niagara.....	66.14	6,051.81
Lucas.....	58.00	5,307.00	Oswego.....	62.88	5,753.52

MARKET AND FIELD INSPECTIONS

Inspection and certification of produce for movement from infested areas to points outside was carried on in the territory infested by the 2-generation strain of the corn borer.

During the entire shipping season inspectors were located at Boston, Mass., Portland, Me., and Providence, R. I.; others operated temporarily at Mansfield and Sharon, Mass.

In Connecticut, it was possible to examine and certify crops in the field. Field inspections were conducted until infestations had been found, after which market inspections were required. The latter were handled at Hartford, New Britain, and New Haven.

New York City had market inspection at the four principal markets—two in Manhattan, one in the Bronx, and one in Brooklyn.

There were but 162 refusals of permits in New York during the 1930 season, less than half the number recorded in the previous year.

The tabular statement below shows the quantities of produce and flowers for which certificates or permits were issued during the 1930 season.

Farm products originating in quarantined area, certified for shipment-----	bushels-----	61, 748
Farm products originating outside of quarantined area, for which permits were issued for shipment-----	bushels-----	90, 533
Cut flowers, plants, roots, and bulbs originating in quarantined area certified for shipment-----	number--	8, 581, 735

TRANSIT INSPECTION AND VIOLATIONS

Minor violations of the corn-borer quarantine by private individuals were reported in unusual number by the transit inspectors stationed in Boston. In nearly every instance, investigation disclosed that ignorance on the part of postmasters in the regulated area was responsible. No willful or flagrant violations were recorded, and cooperation on the part of common carriers and shippers in this area was very satisfactory.

In the western area transit inspection is maintained for this project at the Terminal Belt Stockyards, Indianapolis, Ind., and at the Union Stockyards, Cincinnati, Ohio. Trucks coming from the infested areas are examined to determine whether or not cornstalks, débris, etc., are in use for bedding or feed. The number of violations intercepted at both points made necessary an increase in the number of inspectors, and this activity will be continued until after moth emergence.

DISPLAY AT LIVESTOCK EXPOSITION

An exhibit of the major activities of the European corn-borer quarantine and control work was displayed at the International Livestock Exposition at Chicago, Ill., November 29 to December 6, 1930. Wall space of 1,080 square feet and floor space of 750 square feet were occupied.

Approximately 65,000 people viewed the exhibit coming from nearly every State in the Union. A great deal of interest was manifested by most of the callers and approximately 5,000 bulletins were distributed. The display was complimented as unusually well balanced.

Comparison in yields from infested and noninfested plants was particularly interesting to the visitors. Corn-borer-control machinery attracted the farmers perhaps more than anything else. People from the cities, however, were principally interested in features of quarantine enforcement.

TRANSFER OF SURPLUS PROPERTY

Decision was made about October 1 to transfer all surplus equipment stored at Camp Perry, Ohio, to other branches of the Government. Instructions governing disposition of the material began to arrive early in January.

Most of the surplus was allotted to other bureaus within the Department of Agriculture, though other departments received a considerable portion of it. A large force of employees was required to prepare the machinery for shipment by rail, and to crate some lots for ocean shipment.

CONFERENCES AND DEMONSTRATIONS

The fifth annual conference on European corn-borer activities, both in the United States and Canada, was held at Toledo, Ohio, September 24 and 25, 1930. As heretofore, the attendance was representative of the several interests most vitally concerned in retarding the spread of the pest and in providing adequate methods for its control. The program for the meeting, prepared by officials of the Plant Quarantine and Control Administration, graphically summarized the results of the experimental work done during the preceding seasons. Following full discussion of the many problems involved in the situation, resolutions presented by a committee of the international organization were approved with slight changes. Much interest was manifested in the further progress in utilization of mechanical devices in control work, though inclement weather interfered with demonstrations it had been planned to give at the department farm near Toledo.

Another conference and field meeting was conducted at the Berkeley, Mass., farm, on October 15, 1930.

Recognizing the menace to agriculture in the continuing spread of the European corn borer, the Plant Quarantine and Control Administration has consistently sought to bring about more general use of the mechanical devices for the control of the pest. Since there are indications that the cooperating State agencies and farmers' organizations in the regions most affected are not all sufficiently well informed on some of the available machinery to make the best use of it in their educational work, special attention to this subject has been given in increasing degree.

In the summer of 1928, a 10-day tour of inspection and field study was conducted. As this preliminary inquiry showed the need for a popular bulletin on mechanical control, Circular No. 132, *Fighting the Corn Borer with Machinery in the 2-Generation Area*, was issued last year. Special attention was again given in 1930 to machinery demonstrations, of which a greatly increased number were conducted during that summer and fall. Low-cutting and plowing demonstrations were put on at nearly twoscore Connecticut and Massachusetts points.

In addition to the activities described, sundry contacts were made with implement manufacturers and dealers and calls were made on a number of farm-paper and trade-periodical editors. Data were collected which it is believed will be helpful in the further adaptation of borer-control machinery to New England conditions.

DEPARTMENT OPERATED FARMS

The value of the demonstration farm near Toledo, Ohio, became more than ever apparent during the year, and numerous experiments conducted there showed relatively conclusive results. But from the standpoint of regulatory and control work, the purposes for which it was established have been in such large measure accomplished that it was felt that its future usefulness to the Plant Quarantine and Control Administration does not warrant further participation in its maintenance. Accordingly satisfactory arrangements were made for transferring the entire activity to the Bureaus of Entomology and Public Roads, which, with the Plant Quarantine and Control Administration,

had cooperated in its operation since December 15, 1927, when it was acquired.

The farm contains 299 acres and is located in an area where the corn borer has been numerous for several years. Since its establishment it has been supervised by the administrative officers in charge of European corn-borer control for the Plant Quarantine and Control Administration. The Bureau of Entomology and the Bureau of Public Roads will continue its operation.

Need for premises completely under the control of the cooperating agencies grew out of the difficulties encountered in trying to conduct experimental work on privately owned farms, where research activities could hardly be carried on in a satisfactory manner without conflicting with certain phases of the regular farming operations. In many cases, such limitations made it impracticable to provide the conditions required for dependable findings. Concentration of supervision in a restricted area and elimination of duplicated labor and equipment tended to economy and afforded further reasons for the maintenance of the farm.

Similar difficulties had been met in attempts to train scouts and inspectors in cornfields belonging to farmers. On the farm leased and operated by the Department of Agriculture more thorough methods could be employed, with resulting increase in the efficiency of the field forces. In 1928, 1929, and 1930 nearly 1,100 men received instruction in scouting at the Toledo farm, about 200 of whom with seasonal or other variations in their work, took more than one course. Several hundred men also were trained for inspection duties on quarantine lines, typical stations having been set up for the purpose.

Outstanding among the results of the joint endeavor of the three bureaus was a better understanding both as to the degrees of infestation under which the corn borer becomes a menace to commercial crop production and as to the protective and preventive measures through which the borer population may be reduced below destructive density. Improvement and development of farm machinery for use in control work also was furthered in a material way, use of the farm contributing substantially to the notable advance made in this field.

Implements perfected by the agricultural engineers engaged in this cooperative effort, which have proved particularly useful, include the following: Types of plows which give complete coverage of debris; stationary-knife low-cutting attachment; sled-type stalk shaver, and 3-row shaver attachment for corn cultivators; 4-bar side-delivery rake, with specially shaped teeth, and low-cutting hand hoe. Leading manufacturers are now producing all of this equipment, rendering it available to farmers generally.

Certain of the studies conducted by the Bureau of Entomology must be carried considerably further before the results are established clearly enough to warrant complete confidence in them. Especially interesting among these are experiments seeking immune or resistant varieties of corn and having to do with insecticides for the reduction of corn-borer population.

The demonstration farm made it possible to develop information on the major objectives of regulatory work—preventing the spread of infestation and lessening the capacity of the corn borer to damage

crops—which it would have been difficult if not impossible to obtain through other channels.

The State of Illinois, in cooperation with the United States Department of Agriculture, operated a 17-acre tract in connection with the Toledo farm on which crop rotations and other controlling conditions were made as nearly as possible typical of the same factors in Illinois, and on this plot particular attention was paid to testing varieties for resistance.

In order to concentrate at one point on the Atlantic seaboard the forces engaged in corn-borer investigation and control, a second farm to be used for demonstration and development purposes was acquired December 6, 1929, at Berkley, Mass., in Bristol County. This farm consists of approximately 100 acres, of which 55 or 60 acres are under cultivation. Through the past year, it was operated jointly by the Plant Quarantine and Control Administration, and the Bureaus of Entomology and Public Roads, under the supervision of the administration.

At the Berkley farm, soil and terrain conditions are typical of those in New England. It is in the heart of an area usually more or less heavily infested with the corn borer of the 2-generation strain. Losses occasioned by the pest have in some recent years prevented profitable production of sweet corn, which has considerable economic importance in the district. Here prevention and control measures require applications different from those best adapted to the grain-corn sections.

The farm was used in 1930 by the Plant Quarantine and Control Administration for exhibition and explanation of control methods, as a field center for the showing of special appliances and implements, and to afford practical training for employees in scouting and other field activities. Bureau of Entomology experimental work at the farm has so far been devoted principally to larval survival studies, infestation surveys, insecticide tests, flight-habit studies, bait-trap tests, study of relation of numbers of generations to climatic and host conditions, and of control of the borer on economic crops other than corn. Despite abnormally unfavorable weather conditions, significant results were obtained in a large proportion of the experiments. The Bureau of Public Roads made considerable progress toward determining the procedure and means for effective mechanical aids to borer control in this region.

JAPANESE-BEETLE SPREAD AND CONTROL

Artificial long-distance carriage of the Japanese beetle to isolated localities again was evidenced by the spread of the insect during the fiscal year. The principal spread during 1930 was north and south along the Atlantic coast, and a lesser spread was evident directly west of the generally infested area in Pennsylvania. Nonagricultural commodities transported by freight and coastwise steamship from the heavily infested territory in Philadelphia and vicinity during the period of unusual adult beetle activity, are apparently the principal beetle carriers responsible for these extensions.

Effective November 10, 1930, the quarantine regulations were amended to extend the regulated areas in accordance with the findings during the summer season. Portions of Baltimore and Harford Counties, Md., found uninfested during the scouting season, were

transferred from the generally infested to the lightly infested area. The District of Columbia, Arlington County, and Alexandria, Va., and parts of New Haven County, Conn., and of Cumberland, Perry, and Union Counties, Pa., were transferred from the lightly to the generally infested areas in order to include within that area the infestations at Washington, D. C., Lyon Village and Alexandria, Va., Branford, Conn., and Boiling Springs, Carlisle, and Lewisburg, Pa., respectively. The lightly infested area was increased to include all other newly discovered infestations, with the exception of those at Boston, Mass., Pittsburgh, New Castle, Laughlintown, Ligonier, Altoona, Tipton, and Tyrone, Pa., and Buffalo, N. Y. The infestations at the latter five points consisted of only a single beetle each. The specimen at Buffalo was found in the immediate vicinity of the freight yards at an unfavorable location for beetle establishment. In view of the limited extent of these infestations and their distance from the infested areas it was felt that the spread of the beetle therefrom could be controlled without quarantining the isolated points affected. Lead-arsenate treatments were subsequently applied to the infestations in Boston in order to reduce the beetle population in that city. Further control measures were practiced at the other isolated infestations during the summer of 1931.

Additional territory added to the infested areas involved only a nominal increase in the areas under regulation. There was an actual reduction in the extent of the area designated as generally infested due to the fact that the portions in Baltimore and Harford Counties, transferred to the lightly infested area under the ninth revision of the regulations, effective November 10, 1930, were greater in area than the small amount of territory added. The generally infested area at the close of the fiscal year included 25,543 square miles, a reduction of 52 square miles as compared to the area similarly classified during the preceding year. The lightly infested area on the same date comprised 22,020 square miles, or an increase of 3,727 square miles over the previously designated area of light infestation. The total area now under regulation includes 47,563 square miles, which represents a net increase of 3,675 square miles over the regulated areas effective from March 1 to November 9, 1930. The infestation most remote from the site of the original infestation at Riverton, N. J., is that at New Castle, Pa., an air-line distance of approximately 285 miles from the locality in which the beetle was first discovered in 1916.

FIELD INSPECTION AND INFESTATIONS

At the peak of the 1930 scouting season 98 crews were in the field with a total personnel of 345 men. Of these, 119 were assigned to scouting outside the regulated areas, and 226 scouted nurseries, greenhouses, and other territory within them. In addition to scouting activities throughout all the States under quarantine, distant scouting was also performed in New Hampshire, Ohio, North Carolina, South Carolina, and Georgia. The entire scouting program, both within and outside the regulated areas, included activities in 16 States.

The extent of each previously discovered infestation was determined at Boston, Mass., Providence, R. I., and Cape Charles, Portsmouth, and Norfolk, Va., points outside the Federally regulated area but under State quarantine restrictions, and at Springfield, Mass., New London, Willimantic, Hartford, and Meriden, Conn., Kingston

and Binghamton, N. Y., Athens, Sayre, Lewistown, and Chambersburg, Pa., Delmar, Del., Delmar, Cambridge, Oxford, Chestertown, Federalsburg, Brunswick, and Hagerstown, Md., Washington, D. C., and Lyon Village, Alexandria, and Ballston, Va., points in the lightly infested areas designated in the Federal regulations. The activities in Athens, Pa., Federalsburg, Md., and Ballston, Va., failed to disclose any persistence of the infestations discovered in these localities during 1929. Fewer beetles were collected in Boston, Mass., Willimantic, Conn., Delmar, Del., and Delmar, Md., than had been recovered during 1929. At all other points increased numbers of beetles were collected. Pronounced increases in the degree of infestation were observed at Providence, R. I., Cape Charles, Va., Hartford, Conn., Brunswick and Hagerstown, Md., and Alexandria, Va.

Additional finds which by the number of beetles collected indicate definitely established infestations were made at Plymouth, Mass., Newport, R. I., Pittsburgh, Pa., and Parksley and Newport News, Va., points outside the 1930 regulated areas, and at West Springfield, Mass., and Branford and Danbury, Conn., points within the lightly infested areas.

Slight infestations of only a few beetles each, indicating incipient infestations, were discovered at Westerly, R. I., Laughlintown, Lock Haven, and New Castle, Pa., Attleboro and New Bedford, Mass., Georgetown and Lewes, Del., and Onley, Melfa, and Keller on the eastern shore of Virginia, all points outside the regulated areas, and at Enfield, Conn., South Waverly, Boiling Springs, Carlisle, and Lewisburg, Pa., and Weverton, Md., points within the lightly infested areas.

Finds of a single beetle each were made outside the area regulated under the quarantine, at Waverly and Buffalo, N. Y., Altoona, Tipton, Tyrone, and Ligonier, Pa., and Exmore, Va.; and within the lightly infested area, at Groton and Terryville, Conn., and Frederick and Hyattsville, Md.

Since the infestations discovered during the year are in communities on heavily traveled highways or served by common carriers whose lines pass through the areas most densely infested by the insect, these new infestations may be largely attributed to artificial spread by means of railway and automobile movement.

The 1931 summer scouting was already under way at the end of the fiscal year, with crews operating in Florida, Georgia, North Carolina, South Carolina, Virginia, Maryland, and Delaware. A number of scout finds had been made in Norfolk, Va., and one beetle had been collected in Richmond, Va., by the end of June, 1931.

BEETLE-CONTROL ACTIVITIES

Further applications of lead arsenate to the areas similarly treated during the preceding fiscal year were made at Springfield, Mass., Cape Charles and Norfolk, Va., and Sayre, Pa. Lead arsenate was also applied to a small area near Dearborn, Mich., to which seven carloads of topsoil from the heavily infested area in New Jersey had been transported. Additional lead treatments were applied to the infestations in Portsmouth and Newport News, Va., discovered during the summer of 1930. The treatments at Dearborn, Mich., and Springfield, Mass., were made during the summer and fall of 1930,

respectively. In the latter city only a limited area was treated in order to use up a quantity of stored treating mixture. All of these treatments were made in cooperation with State or city officials or with private firms. All other treating was done during the spring of 1931. The treating material applied at Dearborn, Mich., Springfield, Mass., and Cape Charles, Va., consisted of the previously used mixture of 1 part of powdered lead arsenate, 2 parts of tankage, and 4 parts of sand.

High-pressure sprayers were used for the first time in applying lead arsenate for Japanese-beetle control during the spring of 1931. Constant agitation of the spray mixture by the agitators in the sprayer tanks permitted the successful use of a mix of 1 pound of lead arsenate to 1 gallon of water. The spray was applied to the ground at the rate of 500 pounds of lead arsenate to the acre. Four sprayers were employed on each operation, two in applying the spray and two in supplying the water used to wash the arsenate of lead into the ground. Three to four times as much water was used in the washing operation as in applying the spray. The Worthley nozzle was used for applying both the spray and the wash water. This method has the advantage of reducing the treating mixture to one-seventh its former bulk and of requiring the transportation of only the lead arsenate without the additional 6 parts of tankage and sand. Sufficient data are not yet available upon which to base a comparison of the spray method and the dry application in relative cost per acre, speed of application, effectiveness in controlling the insect, and effect on the treated areas.

Trap-control activities for the 1930 season were already under way at the beginning of the fiscal year. Traps had been in operation in Cape Charles and Norfolk, Va., since the middle of May, and had also been in place for from one to two weeks in other cities in Virginia and Maryland. The majority of the traps, however, were not distributed until the first two weeks in July. Trap work was largely discontinued in the southern portion of the trapped area the middle of August. The traps were then gradually withdrawn from the more northern cities until the program was completed for the season by the withdrawal of the traps in Connecticut and Massachusetts during the second week of September.

Traps and bait were prepared according to the recommendations of the Japanese-beetle research laboratory, Bureau of Entomology, Moorestown, N. J.

Traps to the number of 5,896 were distributed in 23 cities and towns in unregulated territory in Virginia, Delaware, Pennsylvania, Michigan, New York, Rhode Island, and Massachusetts, and 29 trap tenders and supervisors were employed to care for them. The traps collected 4,389 beetles and the trap tenders collected an additional 1,455 beetles by hand.

In the lightly infested areas of Virginia, District of Columbia, Maryland, Delaware, Pennsylvania, New York, Connecticut, and Massachusetts, 18,771 traps manned by 75 trap tenders and supervisors were distributed in 29 towns and cities. A total of 16,730 beetles were caught in these traps, and the trap men collected 6,394 beetles in the immediate vicinity of the traps.

Traps, unassisted by supplemental scouting, were responsible for the discovery of small infestations at West Springfield, Mass., Laughlintown and South Waverly, Pa., and Buffalo and Waverly, N. Y.,

and for the disclosure of an important isolated infestation at Pittsburgh, Pa.

Traps had been distributed for the 1931 season in a number of cities in Georgia, North Carolina, and South Carolina, and at various points in Virginia and Maryland by the end of the fiscal year. Three beetles had been caught in traps at Charleston, S. C., and a number had been trapped at cities in Virginia and Maryland that were known to be infested.

QUARANTINE ENFORCEMENT

The generally infested area during the summer of 1930 had a periphery of 615 miles. Road-inspection posts were already in operation on this border at the beginning of the fiscal year, 34 having been established with the beginning of the farm-products quarantine on June 15. On July 1, 11 additional roads were posted. About one-third of the posts were maintained on a 24-hour daily schedule. The remainder were in operation from 8 to 20 hours each day. All road-inspection activities were discontinued after the first week in September. Vehicles stopped at the road posts numbered 2,931,239 during the 10 weeks of operation at the beginning of the fiscal year. Quantities of uncertified quarantined articles were surrendered at the road posts. Comparatively few cars refused to stop for examination.

The posts presenting the greatest difficulties were those on the Washington Boulevard at Waterloo, Md., on the Lincoln Highway at Gettysburg, Pa., and on the Boston Post Road at Branford, Conn. The heavy truck and automobile movement on these roads necessitated an enlarged corps of inspectors in order to interfere as little as possible with traffic.

Seasonal road-inspection work was started earlier in 1931 than in the preceding year. Early in April, 20 roads were posted, a reduced corps of 25 men being employed in the work. This force was gradually increased until at the end of the fiscal year 28 line stations were in operation, manned by 33 inspectors. Interceptions of 49 *Popillia japonica* larvae were made at the road posts during April, May, and June. These larvae were found in soil about the roots of uncertified plant material, practically all of which was intended for removal to destinations in Ohio, New York, and Pennsylvania at considerable distances from the infested areas.

Probably the greatest innovation in nursery and greenhouse supervision since the original imposition of restrictions on the movement of nursery and ornamental stock, was introduced in the amendment to the regulations which became effective on June 15, 1931. Under the requirements which have been in effect since April 9, 1925, the basis for the classification of nursery and greenhouse establishments has been essentially that class I consisted of premises at some distance from an infestation, class II of establishments on which no infestation had been located but within the general vicinity of which beetles had been collected, and class III of establishments known to be infested or within about 500 feet of which Japanese beetles had been found. The revised regulations redefine the three classifications. Class I establishments consist of premises in the lightly-infested area and on or within approximately 500 feet of which no infestation has been found. Class II establishments now consist of similarly uninfested

premises in the generally infested area. Class III establishments remain as previously defined.

Under the revised regulations, class I establishments are permitted to affix a statement to their regular address label or tag showing the number of their valid Federal permit in lieu of an individual certificate to accompany each package or bulk certificate. The previous requirement for the reporting of each individual shipment has also been waived for nurseries and greenhouses of this class.

The supervision of class II establishments previously involved extensive diggings to determine possible larval infestation, the partial or entire removal of soil from certain plants before certification, the screening of coldframes, the inspection of 10 per cent of plants placed in outdoor frames, and the treatment with lead arsenate of heeling-in or plunging plots. Repeated diggings in class II establishments have failed to disclose any larval infestation previous to the collection of adult beetles on the premises. On this basis, the former prerequisites for certification from class II premises were removed. Discontinuance of these restrictions permits class II establishments to abandon many expensive growing procedures and shipping preparations.

These modifications relieve the inspection officers of a large amount of routine report work and permit the administration of the quarantine requirements with less friction and controversy. At the same time they permit nurserymen and dealers a greater economy of operation and freedom of plant movement.

A distinct change has also been made in the method of applying chemical treatments to plants intended for shipment from the regulated areas. Prior to July 8, 1929, all such plants had been treated with carbon disulphide or by immersion in hot water. Revision of the treating instructions to permit the application of arsenate of lead to nursery plots and the subsequent certification of stock therefrom resulted in over 95 per cent of the total plants treated being handled in this manner. Such treatments did not result in the subsequent certification of all plants in the treated plots, but all stock in the treated areas was eligible for certification and a large proportion of the plants was shipped from the regulated areas.

Another departure from previous practices in connection with the treating of nursery plots and heeling-in areas was a soil-analysis program inaugurated in April and concluded before the end of the fiscal year. The treating manual prescribes that lead arsenate shall be incorporated in the upper 3 inches of the soil throughout the area treated at the rate of 1,500 pounds per acre. In order to determine the amount of material which must be incorporated in the soil to raise its lead arsenate content to the prescribed dosage, representative samples from each treated plot were gathered under the supervision of inspectors of the project and analyzed by chemists temporarily appointed on this project, but working under the supervision of the Bureau of Entomology research laboratory at Moorestown, N. J. Considerable rainy weather during April interfered with the gathering of samples. All analyses had been completed at the end of the fiscal year, but the data had not been completely assembled as a basis for retreatments.

The quarantine on the movement of farm products which was in effect at the beginning of the fiscal year was continued in force until

October 1. The restrictions on these articles do not apply in the detached, generally infested area comprising the District of Columbia and Arlington County and Alexandria, Va. Infestations in these localities were not sufficiently heavy to justify inspection and certification of farm products.

Restrictions on the movement of cut flowers which had been in effect throughout the entire generally infested area since June 15, were continued for the entire period prescribed in the quarantine regulations ending October 15. This was made necessary by existing infestations in greenhouses producing cut flowers. However, the virtual disappearance of adult beetles in the field permitted the lifting of the quarantine on farm products on October 1.

Sixty-nine inspection centers, manned by 137 inspectors, were maintained for inspection and certification of farm products and cut flowers during the effective period of the 1930 summer quarantine. At these centers 8,569,684 packages of farm products and cut flowers were certified and 19,611 beetles were removed. The number of these packages certified for movement from the generally infested areas was 20 per cent greater than in 1929. The increase was notable in all States except New York and Connecticut.

Interstate shipment of unusually large quantities of sweet corn originating in the densely infested area in southern New Jersey accounted for the enormous increase in the number of adult beetles removed from shipments in the course of the summer inspection. In 1929 most of the corn certified originated in northern New Jersey, where the Japanese-beetle population is much smaller than in the southern part of the State.

Another unusual feature was the inspection and certification of hundreds of tons of produce moving from southern New Jersey farms and the Philadelphia markets to the drought-affected regions in Florida, Georgia, North Carolina, South Carolina, Virginia, Maryland, and Ohio. Practically all of this produce was transported by fast truck.

Adult beetles were again in heavy flight in the market and waterfront districts of Philadelphia from the second week in July until the middle of August. The usual procedure of curtailing inspection service and making it available only during the quiescent period of the beetle from 8 p. m. until 10 a. m., was, therefore, resorted to from July 10 to August 13.

VIOLATIONS

There was an increase of over 25 per cent in the number of violations reported for investigation during the fiscal year as compared to the preceding year. During the last half of 1930, 548 violations were investigated through the Camden headquarters and 310 violation reports have been received during the first half of 1931. Of these shipments 700 were intercepted in the mails, 120 while in transit by express, 5 by freight, and 5 by steamship. Uncertified material moving by truck or automobile constituted 28 violations reported by road posts. All violations were reported by employees of the administration except 12, which were brought to the attention of the administration by collaborators of the Department of Agriculture operating in Florida.

In March, the transit inspection organization took over the advisory supervision of the two transit inspectors of this project stationed in Philadelphia.

TREATMENTS AND CERTIFICATIONS

Table 13 shows the quarantined articles intended for shipment from the regulated areas or for use in certified greenhouses, which were chemically fumigated or sterilized during the fiscal year 1931:

TABLE 13.—*Materials fumigated or sterilized under Japanese-beetle quarantine regulations, fiscal year 1931*

Material	Treated with—				
	Arsenate of lead	Carbon disulphide gas or emulsion	Hot water	Steam	Hydrocyanic acid
Plants.....number.....	515, 829	5, 373	17, 721		
Potting soil.....cubic yards.....		4, 561		2, 926	
Sand.....do.....		3, 344			
Leafmold.....do.....		195			
Surface soil.....square feet.....	294, 456	35, 316			
Surface soil with plants.....do.....	2, 857, 537				
Bananas.....bunches.....					122, 349
Berries.....crates.....		7, 397			

The quantities of nursery and ornamental stock, sand, soil, earth, peat, compost, and manure certified for shipment from the regulated areas during the fiscal year were as follows:

Plants.....number.....	67, 665, 592
Sand, earth, and clay.....carloads.....	8, 925
Peat.....do.....	527½
Manure.....do.....	869

The amount of farm produce certified for shipment from the generally infested area and the quantity of cut flowers certified for movement from both regulated areas during the fiscal year were as follows:

Fruit and vegetables.....packages.....	8, 721, 039
Hay, straw, and moss.....bales.....	49, 400
Cut flowers.....boxes.....	42, 131

COOPERATION FROM STATES AND CITIES

As heretofore, helpful cooperation in the enforcement of quarantine regulations and in the application of control measures against the Japanese beetle has been received by the administration from the collaborating States of Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, and Virginia. Cooperation of a similar and satisfactory character also was extended by the city park departments of Boston and Springfield, Mass., and Hartford, Conn.

PINK BOLLWORM

SALT RIVER VALLEY SITUATION

The most important development in the pink-bollworm situation during the fiscal year was the discovery that the infestation in the Salt River Valley of Arizona was more extensive than had previously

been believed. It will be recalled that a noncotton zone was established for the 1930 crop, extending 2 miles beyond the outermost known infested sections and that all cotton fields within this zone had been thoroughly cleaned in the spring of 1930. It was hoped that these steps would entirely eradicate the pest from that area, as had been done in certain other areas in former years. The discovery of many slight, widely scattered infestations in the 1930 crop at points outside the noncotton zones, however, showed that these zones had not been large enough to accomplish the eradication of the pest throughout the Salt River Valley.

The inspection of cotton in the valley was begun about July 1 and was especially intensive. The entire valley was divided into small areas, the smallest being located nearest the noncotton zone. Each area was inspected weekly, the inspection consisting of the examination of 100 bolls, or 200 squares when bolls were not available, as was the case early in the season.

In connection with the scouting program, a gin-trash machine was put into operation near Tempe the latter part of August, and the first pink bollworm was taken on September 6. The cotton from which this specimen came was traced to a field about 8 miles west of the noncotton zone. Other gin-trash machines were operated in the Salt River Valley during the season at Tolleson, Buckeye, Glendale, and Coolidge. After the first finding, specimens were taken almost daily as long as the machines were operated.

The first pink bollworm discovered by field inspectors was taken on October 2 in a planting which the examination of gin trash had previously shown to be infested. The difficulty of finding the specimen in the field indicates that the infestation is very light.

The season's surveys as a whole and the operations of the gin-trash machine showed that infestations existed in the 1930 crop near Glendale, Avondale, Laveen, Phoenix, Tempe, Lehi, Helena, Good-year, and Queen Creek, in Maricopa County, and Casa Grande and Coolidge, in Pinal County. As the 1930 noncotton zones were consistently maintained, no pink bollworms were found in them, and they are now believed to be more nearly free of infestation than other sections of the Salt River Valley.

It did not seem practicable to maintain the noncotton zones during the 1931 crop season, because of the widespread infestations found in the 1930 crop. Therefore a new plan of operation, less expensive than noncotton zones, thought to be better adapted to the large area involved, was decided upon. The Arizona State Commission of Agriculture and Horticulture issued an order on December 16, 1930, defining certain regulated areas and prescribing the requirements to be followed therein. Four of these regulated areas are in Maricopa County, two in Pinal County, and one occupies parts of both Maricopa and Pinal Counties. Another area is in Pima County, but outside the Salt River Valley. The regulated areas comprise about 530,000 acres, including desert and cultivated land, of which some 80,000 acres have heretofore been planted to cotton. All fields which were in cotton in 1930 are required to be thoroughly cleaned and plowed by the middle of February. No stub cotton or so-called "volunteer" cotton is permitted to be grown in any part of the areas, no Pima cotton is allowed to be planted prior to April 1, and no upland cotton may be planted prior to April 20.

Steps were immediately taken to begin the cleaning up of the fields, which was to be done by the individual farmers; however, a number of difficulties were encountered. Due to the comparatively high price paid for lower-grade cotton, an unusual amount of bollie cotton was gathered, the harvesting of which extended late into the season. Another and most serious handicap was the financial condition of the farmers. A great number were unable to meet water assessments which had to be paid in order to obtain water for irrigation in connection with the plowing. The clean-up campaign was carried on as well as could be expected under these handicaps, 62 per cent of the total cotton acreage being cleaned. This figure does not indicate the full value of the clean-up, since practically all the infested fields, with the immediate surrounding areas, were cleaned. The extent of the clean-up work by areas is shown in Table 14.

TABLE 14.—*Extent of clean-up of 1930 cotton acreage in the regulated areas of Maricopa and Pinal Counties, Ariz.*

Area	Total cotton acreage	Acreage cleaned	Acreage not cleaned	Percentage cleaned
No. 1, Avondale.....	16,959	7,760	9,199	46
No. 2, Glendale.....	8,099	7,463	636	92
No. 3, Laveen.....	4,246	3,434	812	81
No. 4, Lehi-South Avenue.....	10,977	9,119	1,858	83
No. 5, Chandler.....	14,884	3,006	11,878	20
No. 6, Coolidge.....	18,076	14,111	3,965	78
No. 7, Casa Grande.....	5,642	3,852	1,790	68
Total.....	78,883	48,745	30,138	62

Immediately following the field clean-up, a preliminary survey was made of the newly planted alfalfa fields. It was found that cotton was present in some form in 11.3 per cent of this acreage. Therefore, it was considered advisable to inspect all alfalfa fields in the Salt River Valley. At the same time, other crops were inspected to determine whether they were also contaminated with cotton. This work had not been quite completed at the end of the fiscal year. At that time, 78,419 acres of alfalfa had been inspected, showing some form of cotton present in about 30 per cent of the acreage; and cotton was present in some 10 per cent of 81,107 acres devoted to other crops. The total cultivated cotton acreage was found to be 107,990½, while 27,755 acres planted to cotton in 1930 had been abandoned.

Meanwhile, claims for compensation because of the establishment of noncotton zones in Maricopa and Pinal Counties, Ariz., during the fiscal year 1930, have been considered by the compensation claim board appointed by the Secretary of Agriculture under the provisions of Joint Resolution No. 42 of the Seventy-first Congress. During the year, this board disposed of claims covering practically all such parts of these zones as had formerly been planted to cotton. Payment of the majority of these claims has already been made, the funds being provided by an item of \$675,000 included in the first deficiency bill, which was passed and approved in February, 1931.

ANNUAL SURVEY IN THE EL PASO VALLEY

Intensive inspections have been made in the El Paso Valley in Texas each year since 1920 to determine the extent to which the infestation has varied from year to year. The Ivy-Dale ranch has

been used in these inspections, as it has been regularly planted to cotton and seems to present an average condition for the valley. The altitude is approximately 3,500 feet and cotton is frequently subjected to early frost damage. Gin-trash disposal, seed sterilization, and compression and fumigation of lint have been in effect for a number of years. Inspections amounting to 54 man-days are made each season. The results of this season's survey and previous surveys are given in Table 15.

TABLE 15.—*Annual fluctuations of pink-bollworm infestation in the El Paso Valley, 1920-30*

Crop year	Month of scouting	Specimens collected			Crop year	Month of scouting	Specimens collected		
		Alive	Dead	Total			Alive	Dead	Total
1920	December.....	0	5	5	1926	January and February	0	2	2
1921	do.....	3	155	158	1927	January.....	1	11	12
1922	December and January	11	63	74	1928	February.....	0	0	0
1923	January.....	0	0	0	1929	January.....	0	0	0
1924	January and February	0	3	3	1930	December and January	0	22	22
1925	December and January	0	252	252					

STATUS OF OLDER AREAS OF INFESTATION

Use of gin-trash machines showed the pink bollworm to be present in all of the older areas of infestation from Midland County, Tex., to eastern Arizona, with the exception of the Duncan Valley which extends across the State line from Arizona to New Mexico. In this latter area, the amount of trash examined was too small to warrant any definite conclusion. No infestation was found during the year in the so-called "western extension" of Texas, northeast of Midland County, and on November 17 that area was released from quarantine. No pink bollworms have been found there since 1927.

In the Big Bend section and the lower El Paso Valley in Hudspeth County (both in Texas), the infestation was extremely heavy, but it was very light in the other areas. Pink bollworms were also found in trash from all gins in the Juarez Valley in Mexico.

Only 14 infested fields were found by field inspection, 2 of these being in the western extension of Texas, 1 in the El Paso Valley of Texas, and 11 in the Salt River Valley of Arizona. In the majority of cases in the Salt River Valley, the examination of gin trash had previously shown these fields to be infested. Scouting in the Salt River Valley was more intensive this season than heretofore, and the scarcity of field discoveries of the insect therefore demonstrated the value of the gin-trash machine in locating light infestations.

Outside the regulated areas, the gin-trash machines were operated in various parts of California, Arizona, Texas, and New Mexico, with negative results. The number of pink-bollworm larvae discovered and the number of bushels of trash examined up to December 31, 1930, are shown in Table 17. Field inspections outside of the regulated area numbered 3,397 and covered a much larger territory than heretofore. They were as follows.

	Number of inspections
Lower Rio Grande Valley of Texas.....	1, 225
Lower Rio Grande Valley of Mexico.....	230
The southern part of California.....	1, 071
Western Arizona.....	165
New Mexico.....	90
Texas.....	599
Miscellaneous inspections in various other cotton States.....	17
Total.....	3, 397

A different method of field inspection was used this season, the inspections being made on a basis of 100 bolls to a field—20 from each corner and 20 from the center. Under this plan an inspection of 100 bolls is now used as a unit, in lieu of a man-day as heretofore. In making comparisons with scouting in previous years, a man-day is rated as equivalent to about four field inspections.

In the process of ginning, an average of about 1 bushel of trash is taken from a bale of cotton. Approximately 10 acres are picked over to secure enough seed cotton to make a bale. It will thus be seen that each bushel of gin trash examined is equivalent to an inspection of 10 acres. During the year, 79,069 bushels of trash were examined with the gin-trash machines; 67,880 bushels of this were from gins located in infested areas previously discussed. The remainder, 11,189 bushels, would represent the inspection of 111,890 acres. The greater part of this outside material came from western Arizona and adjacent sections of California, 9,691 bushels from these sections having been examined. In the Imperial Valley of Lower California, Mexico, 730 bushels were examined. The examination in these three areas was considered advisable because of the continued infestation in the Salt River Valley of Arizona. Two hundred and twenty-one bushels were examined in the lower Rio Grande Valley of Texas and the remainder was from other sections of Texas.

In previous years, it has been the custom to collect samples of bolls to be inspected at the close of the regular field-inspection season. The most effective time for finding an infestation in the field is during October and November; therefore samples consisting of 100 green bolls each were collected from the various cotton States during this period and placed in a preservative. An inspection laboratory was opened in San Antonio, Tex., and the various steps to be followed in the inspection of these bolls were worked out prior to the close of field inspection. Briefly, these steps are:

- (1) The green bolls are taken from the containers and passed between rollers to crack them;
- (2) they are soaked in a vat of water for 24 hours to dilute the formalin used as a preservative;
- (3) the water is removed by a centrifugal machine;
- (4) inspectors remove the lint and examine the bolls for typical signs of the pink bollworm;
- (5) the lint is sent through a heated tumbling machine for drying, after which it is ginned. The gin is equipped with a special beater which separates any substances like the pink bollworm from the lint; and
- (6) the seed are embedded in paraffin blocks and run through a slicing machine. This machine is set so that each seed is cut. Inspectors then examine the slices.

The possibility of overlooking a pink-bollworm infestation in the material seems to be reduced to a minimum.

The field inspection was completed early in January, at which time the laboratory was officially opened. The purpose of the laboratory is to cover lightly a very large area without facilities for inspection in any other manner. Considerable attention was given to selecting the fields from which samples were obtained, and it is thought that the above method of inspection should give a fairly accurate idea of the presence or absence of the pink bollworm in the main Cotton Belt. This method is more thorough than field inspection, as it provides for the examination of each seed, which is impracticable under field conditions. Also, a much larger number of bolls per day can be examined by the laboratory method. Since the material was collected when it was at the best stage for inspection, the effect of laboratory inspection is the same as though it were done during the most effective period. Approximately 22 inspectors were engaged in laboratory work, which was completed the latter part of June.

The results of each of the above methods of inspection are shown in Tables 16 and 17 and in the tabulation immediately following.

TABLE 16.—*Summary of field scouting for the pink bollworm for the crop year 1930*

Area and district	Field inspections ¹	Infested fields	Area and district	Field inspections ¹	Infested fields
Infested areas:			Infested areas—Continued.		
Pecos Valley, N. Mex.-----	100	0	Duncan Valley, Ariz. and N. Mex.-----	2	0
Pecos Valley, Tex.-----	40	0	Safford, Ariz.-----	11	0
Western extension of Texas....	913	2	Salt River Valley, Ariz.-----	3,415	11
Big Bend, Tex.-----	(²)	(³)	Tucson, Ariz.-----	14	0
Big Bend, Mexico-----	(²)	(³)	Suspicious areas:		
Juarez Valley, Mexico-----	0	0	Lower Rio Grande, Tex.-----	1,225	0
El Paso Valley, Tex.-----	214	1	Lower Rio Grande, Mexico....	230	0
Mesilla Valley, Tex. and N. Mex.-----	46	0	Other areas-----	1,942	0
Tularosa, N. Mex.-----	0	0	Total-----	8,154	14
Deming, N. Mex.-----	2	0			

¹ Four field inspections represent approximately one man-day, the term used in previous years.

² Research examinations.

³ Heavy infestation; exact number of fields not recorded.

TABLE 17.—*Summary of gin-trash inspection for the pink bollworm for the crop year 1930*

Area and district	Trash examined	Specimens found	Area and district	Trash examined	Specimens found
Infested area:			Infested area—Continued.		
Pecos Valley, N. Mex.-----	<i>Bushels</i> 3,706	<i>Number</i> 23	Duncan Valley, Ariz. and N. Mex.-----	<i>Bushels</i> 29	<i>Number</i> 0
Pecos Valley, Tex.-----	755	13	Safford, Ariz.-----	1,956	3
Western extension of Texas....	34,711	1	Salt River Valley, Ariz.-----	21,420	1,271
Big Bend, Tex.-----	59	61,069	Tucson, Ariz.-----	1,236	4
Big Bend, Mexico-----	0	0	Suspicious areas:		
Juarez Valley, Mexico-----	424	218	Lower Rio Grande, Tex.-----	221	0
El Paso Valley, Tex.-----	2,027	7,037	Lower Rio Grande, Mexico....	0	0
Mesilla Valley, Tex. and N. Mex.-----	1,458	42	Other areas-----	10,968	0
Mex.-----	44	1	Total-----	79,069	69,701
Tularosa, N. Mex.-----	55	19			
Deming, N. Mex.-----					

¹ Special tests were run with trash from a gin in Hudspeth County, Tex., and 6,918 additional specimens taken.

The number of boll samples¹ inspected at the San Antonio laboratory of the 1930 crop were as follows: From Alabama, 881; Arkansas, 730; Florida, 120; Georgia, 1,000; Louisiana, 1,110; Mississippi, 1,209; North Carolina, 230; Oklahoma, 100; South Carolina, 744; Tennessee, 99; and Texas, 3,357; a total of 9,580.

SPECIAL SCOUTING IN MEXICO

Further scouting in Mexico was carried on during the first four months of the fiscal year, to develop more information on points left in doubt by last season's work. It was done in cooperation with the Oficina para la Defensa Agricola of the Mexican Department of Agriculture. In the States of Tamaulipas and Nuevo Leon, 2,776 acres of cotton were inspected, each planting being inspected during July and again in August, with negative results. Conditions for inspections were favorable, due to the fact that they were begun earlier this season than last.

The cotton plantings in the San Carlos-Allende district of Coahuila, where a light infestation previously existed, were also inspected with negative results. Several dry years since the last infestation was discovered, with consequent crop failures, may have caused the infestation to die out.

The wild host-plant inspection in the district between the Laguna and the border was carried on with most attention being given to the inspection of fruit of *Hibiscus cardiophyllus* and *Abutilon hypoleucum*. Rains throughout the summer had caused the plants to fruit plentifully, so that inspection conditions were good. Aside from infestations on *H. cardiophyllus* in the Campana Mountains, which were to be expected on account of the immediate proximity to heavily infested cotton fields, only two other light infestations were found, both of these being on *H. cardiophyllus*. The first finding consisted of two specimens of the pink bollworm on August 18 and the second of one specimen on October 4, in canyons about 1 mile apart on the north side of the Sierra Mojada Range, about midway between the Laguna and the border. Particular attention was given to inspecting the malvaceous plants in the vicinity of Cuatro Cienegas, where one specimen of the pink bollworm was taken from *A. hypoleucum* last season. Although fruiting was plentiful, no recurrence of the infestation was found. Such data on these wild-host plants as are now available indicate that they would not be effective in carrying over an infestation in the absence of cotton plantings. The extreme rarity of their occurrence and infestation by the pink bollworm, the irregular fruiting habits due to frequent prolonged droughts, and the difficulty which newly hatched pink-bollworm larvae have in entering the pods of *H. cardiophyllus*, lead to this conclusion. The possibility that such plants occur in large numbers in the wild parts of some mountain ranges in regions where sufficient rainfall is obtained to insure regular fruiting and thus furnish a food supply to carry over the insect, needs to be investigated further, although the limited number of such investigations thus far made have indicated that such conditions do not exist.

¹ Each sample consisted of 100 bolls; no pink bollworms were found during these examinations.

QUARANTINE ENFORCEMENT

In controlling and preventing the spread of the pink bollworm from the infested areas of west Texas, New Mexico, and Arizona, the more important measures consist of disposal of gin trash, sterilization of seed, supervision of oil mills handling seed produced in infested areas, fumigation and compression of lint, and operation of road-inspection stations.

Disposal of gin trash.—All gins are equipped with cleaning machinery through which the cotton first passes in the process of ginning. This machinery removes a considerable amount of trash from the cotton and in infested areas, many pink bollworms are discharged in this trash, which the regulations require to be disposed of daily by burning, sterilization, or grinding.

Modifications have already been made by the New Mexico State authorities in regulations for the disposal of gin trash next season. These modifications require the daily disposal of the trash until after the killing frost date in the area in which the gin is located, this date to be determined by the inspector in charge of the locality. Thereafter the trash may be removed by farmers for feeding, fertilizer, or other purposes.

Seed sterilization.—All seed produced in regulated areas must be sterilized. The gins are equipped with sterilizers, through which the seed passes continuously during ginning, and in which it is heated to a temperature of 145° F. Each sterilizer is equipped with a thermograph that is checked daily, so that a continuous record is made. During the season, 151,336 tons of seed were sterilized by the 179 gins in the regulated area. A check of the thermograph charts showed that the required temperature was maintained by the gins for 97 per cent of the time of operation, a record higher than has been made in any previous year.

Supervision of oil mills.—The absence or scarcity of oil mills in certain sections makes it necessary to authorize mills outside the regulated area to crush quarantined seed. The mills so authorized this season are located at Colorado, Sweetwater, Abilene, Lubbock, and Slaton, Tex. The seed must be hauled to these mills in sealed cars, unloaded, segregated, and crushed during the winter or early spring prior to May 1. All cars hauling seed to oil mills are thoroughly cleaned before being released, regardless of whether the mill is within or outside the regulated area. The seed is required to be crushed in such a manner as to destroy all pink bollworms; and any seed, linters, or grabbots must be segregated until they have been treated in accordance with regulations in order to prevent the contamination of finished products. During the season, 139,342 tons of seed were crushed at the 25 mills operating. These mills were all thoroughly cleaned at the end of the season.

Lint fumigation.—Ten vacuum fumigation plants were operated in the regulated area this season as follows: Big Spring, Marfa, Fabens (two plants), and El Paso, Tex.; Las Cruces (two plants), and Roswell, N. Mex.; Tucson and Phoenix, Ariz.

Under the pink-bollworm quarantine regulations in effect since January 1, 1930, permits may be issued for the interstate movement of compressed cotton lint from the pink-bollworm-regulated areas without fumigation when the lint has been produced in counties within which and within 5 miles of which (1) no pink bollworm infesta-

tion has been found during the present or two preceding crop seasons, (2) no infested seed cotton is known to have been ginned during such period, and (3) all cottonseed produced has been sterilized. Under these provisions, the fumigation requirement was removed, effective June 1, 1930, as to Chaves, Eddy, and Otero Counties, N. Mex., and Andrews, Glasscock, Martin, and regulated parts of Borden, Dawson, and Howard Counties, Tex. Due to the discovery of infestations this season, it was necessary to reinstate the fumigation requirement in Eddy and Otero Counties, N. Mex., on October 20, 1930, and Chaves County, N. Mex., on November 20. Glasscock and Martin Counties, and the formerly regulated parts of Borden, Dawson, and Howard Counties, Tex., were removed from the regulated areas and released from all pink-bollworm-quarantine restrictions on November 17.

Table 18 shows the amount of cotton fumigated at the various plants for the 1930 season; Table 19 shows the amount of lint and linters compressed for the same crop during the period while the fumigation requirement was waived.

TABLE 18.—*Cotton lint and linters, both compressed and fumigated, 1930 crop*¹

Location of plant	Lint	Linters	Total
	<i>Bales</i>	<i>Bales</i>	<i>Bales</i>
Big Spring, Tex.....	12, 556	696	13, 252
Marfa, Tex.....	4, 466	566	5, 032
Fabens, Tex. (two plants).....	42, 866	2, 471	45, 337
El Paso, Tex.....	3, 840	4, 145	7, 985
Roswell, N. Mex.....	26, 314	657	26, 971
Las Cruces, N. Mex. (two plants).....	57, 190	2, 138	59, 328
Tucson, Ariz.....	13, 839	2, 234	16, 073
Phoenix, Ariz.....	100, 749	3, 831	104, 580
Total.....	261, 820	16, 738	278, 558

¹ 233 bales of Mexican lint and 435 bales of Mexican linters are included in above figures.

TABLE 19.—*Cotton lint and linters, compressed but not fumigated, 1930 crop*

Location of plant	Lint	Linters	Total
	<i>Bales</i>	<i>Bales</i>	<i>Bales</i>
Big Spring, Tex.....	9, 834	-----	9, 834
Lamesa, Tex.....	16, 405	-----	16, 405
Roswell, N. Mex.....	21, 364	108	21, 472
Total.....	47, 603	108	47, 711

Road stations.—During the 1930 crop season, road stations were maintained at Alpine, Fort Davis, and Valentine, Tex. These stations are for the purpose of controlling the highway movement from the heavily infested Big Bend area. The three stations inspected 42,224 cars, and made 994 interceptions from them. Specimens of the pink bollworm were found in 15 of these interceptions, living specimens being found in 8. A total of 34 living and 143 dead pink bollworms was taken. Most of the interceptions consisted of small lots of cottonseed or seed cotton, cotton pick sacks, and pillows made of seed cotton. Cotton pick sacks to the number of 219 were passed after being boiled long enough to kill any insects they might contain. Other intercepted material was destroyed.

Cooperation with Mexico.—As in previous years, all cotton in Mexican areas adjacent to the regulated area in the United States was

produced under regulations similar to those enforced in regulated areas in this country. All gins within these Mexican areas are equipped with sterilizers which are operated under the supervision of our inspectors. On the whole, these sterilizers gave very good results during the season. A thorough clean-up is made of the gins and premises at the close of the ginning season. Under these safeguards, the lint is permitted to enter this country under bond for compression and fumigation, after which it is handled in the same manner as cotton produced in regulated areas within the United States. The Mexican officials and citizens have shown a fine spirit of cooperation in carrying out these safeguards.

THURBERIA WEEVIL

Under a cooperative agreement, quarantine and regulatory work in connection with the *Thurberia* weevil is under the direction of the Plant Quarantine and Control Administration, while the scouting to determine the spread of the weevil is performed by the Bureau of Entomology in connection with its research work on the insect.

The *Thurberia* weevil is generally distributed in all the cotton areas of the Santa Cruz Valley, Ariz., extending from southern Pinal County on the north, to Tubac in Santa Cruz County on the south. There has been a slight increase in the percentage of infested bolls; however, the damage is still below what would be considered as of commercial importance.

The same safeguards are carried out in preventing the spread of the *Thurberia* weevil as are used for the control of the pink bollworm. These consist of sterilization of seed as a continuous process during ginning, compression and vacuum fumigation of lint, and a thorough clean-up of gins, oil mills, etc., at the close of the season's operations. The results of this work are included in those already given for the pink bollworm.

MEXICAN FRUIT WORM

The main phases of the work of the Mexican-fruit-worm project for the fiscal year consisted of the enforcement of the last half of the host-free period which had begun on March 1, 1930, and of the first half of the period which began March 1, 1931, the inspection and certification of fruit during the shipping season, the clean-up of infested areas in Texas and adjacent Mexico, the elimination of alternate host fruit trees, and the tabulation of fruit trees growing during the year 1930-31.

INFESTATIONS

The outstanding development in the Mexican-fruit-worm situation was the finding of an infestation, after an interval of approximately 17 months, on the United States side of the Rio Grande. This infestation was discovered on April 22, 1931, in fruit held in storage about 1 mile northeast of Mission, Hidalgo County, Tex. The infested fruit, about $2\frac{1}{2}$ bushels, had been picked February 28 and was stored in sand. Immediately upon finding the infestation, a survey was made of the area within a radius of one-half mile from the infested grove, and the fruit held in storage within this area, amounting to about 10 bushels, was destroyed. A thorough inspection of all other fruit held in storage within the quarantined area gave negative results. Approximately 24 months had elapsed since the last previous fruit-worm outbreak had been found in Hidalgo County in April, 1929.

In September, 1929, a rather general infestation was found in local fruit in Matamoros, Mexico, across the river from Brownsville, Tex. In cooperation with the Mexican authorities all fruits were stripped from the trees in that city, traps were placed in the more heavily infested patios, and the trees throughout the city sprayed at weekly intervals with a poison bait. Spraying was continued for more than a year and was not stopped until December 6, 1930, about a month after the last adult Mexican fruit fly was trapped on November 4. The trapping and inspection operations were kept up, and on April 9, 1931, an infestation was found in sour oranges growing in the patio of one of the places which had been heavily infested in the fall of 1929. Subsequent inspections developed that 13 premises within the city of Matamoros were infested. Larvae were found feeding in sour oranges, Sapote blanco, and *Sargentia greggii* (another species of sapote). In cooperation with the Mexican officials a clean-up crew was organized and all citrus and Sapote fruits were stripped from the trees and destroyed by burial. Following the clean-up operations the application at weekly intervals of the poison-bait spray was resumed in the areas surrounding the infested premises.

Of especial interest was the finding of larvae feeding in half grown, or smaller, fruits of *S. greggii*. This appears to be one of the favored host fruits in Matamoros. In the immature stages of the fruit, the larvae feed in the seed, and in the mature stages they feed in the meat of the fruit.

An excellent spirit of friendliness and cooperation has been exhibited by the officials and private citizens of Matamoros in the eradication work that has been carried on in that city.

HOST-FREE PERIOD

From March 1 to September 30 of each year no host fruit within the quarantined area is allowed to reach a stage of maturity in which it would be acceptable to the fruit fly for oviposition. In connection with the enforcement of this regulation, each bearing tree is inspected immediately after the close of the harvesting season, March 1, to see that no fruit has been left. Further inspections are made during the summer to find and remove any "October-bloom" fruit that might be on the trees and that would ripen during the summer months. It is also necessary to inspect at frequent intervals the few remaining alternate host trees to see that all fruit is kept picked off. As in previous years, the growers of the valley complied fully with these requirements.

INSPECTIONS

Grove inspections were started September 1, 1930, and repeated at 30-day intervals until all fruit had been cleaned from the trees early in March. These grove inspections are made for the twofold purpose of locating infestations and for enforcing sanitary requirements in the groves. Where "drops" are allowed to accumulate on the ground or the grove is allowed to become too weedy, permission to move fruit from that particular grove is refused until it has been placed in the proper sanitary condition. During the season 25,083 grove inspections were made. It was necessary to withhold only 1,457 certificates of grove inspections because of the presence of fallen fruit or of weeds in the groves—about 6 per cent of the total number issued.

At the beginning of the host-free period on March 1 each bearing tree within the quarantined area was inspected to see that all ripe and off-bloom fruit had been removed. It was found that the growers had made an excellent effort to get all the fruit off the trees, it being necessary in only a very few cases to have them go back over the trees because of an excessive amount of fruit having been overlooked.

Packing and canning plants were inspected daily while they were operating. Fruit in the process of being packed was inspected for infestation and records of the plants were checked to see that fruit was not being received from unpermitted groves.

Inspections of fruits growing locally in Matamoros were carried on regularly with occasional inspection trips to outlying ranches and villages along the river. In addition to the inspection of fruits, traps baited with orange juice and orange-extract solution were maintained in some 20 patios in Matamoros. These traps were inspected and rebaited twice weekly.

Arrangements were continued throughout the year whereby the merchants in the city market saved all spoiled fruit for inspections which determined infestations in apples, apricots, guavas, mangoes, oranges, peaches, pears, plums, and quinces. These infested fruits originated largely in the southern part of the Republic of Mexico.

SPECIMENS COLLECTED

The primary purpose of making inspections of fruit is to determine the presence or absence of the various stages of the fruit fly. Since there are numerous other larvae that might be mistaken for those of the fruit fly under field conditions, inspectors were required to submit all specimens resembling the fruit-fly larva to an expert for determination. During the year 59,258 specimens were identified of which 5,069 were various stages of the fruit fly. Of the *Anastrepha* 9 were taken in Texas, 2,134 were taken in traps and fruit produced locally in Matamoros, 2,873 were taken from fruit imported to the market at Matamoros, and 53 were taken from imported fruit in Reynosa, Nuevo Laredo, and Cuatro Ciénegas, Mexico.

During the year a total of 5,846 collections of insects were made.

ROAD STATIONS

Traffic-inspection stations were maintained on the two highways leading out of the valley from the latter part of September, 1930, to March 21, 1931. During this period 62,857 vehicles were inspected, of which 17,033 were found to be carrying fruit, 3,557 in violation of the regulations. The owners were given the choice of returning their fruit to the valley for proper certification, or of having it destroyed at the stations, or, where there were only a few fruits involved, of eating it before passing the station. During the time the stations were in operation 167¼ boxes of fruit were returned to the valley for certification.

ELIMINATION OF ALTERNATE HOST FRUIT TREES

Throughout the year efforts were continued toward the destruction of the summer-ripening host fruits, with the result that 803 such trees were destroyed. While the great majority of these were seedlings that had come up during the year, a number were old trees that had been standing since the quarantine was inaugurated in 1927.

This brings to 39,564 the total number of such trees that have been voluntarily destroyed by 4,936 owners since the quarantine has been in effect. There remain in the quarantined area 126 such trees which the owners have refused to take out but from which they have kept the fruit picked in accordance with the regulations.

SHIPMENTS OF FRUIT

The citrus trees of the valley were severely injured by the freeze of January, 1930, with the result that the crop was about 1,000 cars short of that shipped during the season of 1929-30. During the past shipping season 2,620 solid cars of fruit and 119 mixed cars of fruit and vegetables were shipped by rail, seventy-four thousand and twenty-six 85-pound boxes (approximately 206 carloads) were shipped by express, and 312,813 boxes and baskets (approximately 898 carloads) were carried out by truck and passenger car. In all, 3,843 carloads of fruit were moved from the quarantined area during the shipping season of 1930-31. In addition to the fresh fruit shipped from the valley the six canning plants utilized approximately 1,909 tons or around 159 carloads.

Packing and shipping permits were issued to 124 firms and individuals. As in previous years, an effort was made to limit the issuance of such permits to those firms doing a commercial packing business. Most of the growers and individuals shipping only a few hundred boxes took advantage of the single-box permit system and shipped under the inspectors' general permits.

PUBLIC HEARINGS

The general pest control law of Texas, under authority of which the control work is carried on, was revised and considerably strengthened by the second called session of the forty-first legislature of Texas. While the revised law validated the quarantines and proclamations which had been issued on account of the fruit fly, it was deemed advisable to reissue these State quarantines and proclamations under specific authority of the revised law. Accordingly public hearings were held before the commissioner's courts of Cameron and Willacy Counties on May 16 and 17, 1930, respectively. These hearings were well attended by representative growers and packers who were unanimously in favor of the control measures as outlined. Following these hearings proclamations were issued by the commissioner of agriculture of Texas, effective July 1, 1930, giving in detail the measures to be followed in the control of the Mexican fruit fly. After the hearing in Hidalgo County on March 20, 1931, the commissioner issued a proclamation similar to those covering Cameron and Willacy Counties, effective April 11, 1931.

EXPERIMENTAL STERILIZATION

In order to test the reaction of various varieties of valley fruit to sterilization by heat under the process developed in Florida, an experimental sterilization room was installed in one of the packing plants in Brownsville in October. Tests on different varieties of fruit at different stages of maturity were uniformly successful.

CENSUS OF FRUIT TREES

A count of the citrus trees growing in the quarantined area showed a total of 6,634,049 trees on April 1, 1931. Of these 869,389 were planted in orchard form during the period from April 1, 1930, to March 31, 1931. The supply of trees for planting was seriously curtailed by the freeze of January, 1930, which severely injured the nursery stock in the valley.

DATE-SCALE ERADICATION

During the fiscal year 1931, the second under the cooperative agreement between the administration and the States of California and Arizona, the eradication program against date scale was continued as in 1930. The inspection force was more experienced and knowledge of the distribution of palms and the histories of gardens had been increased by previous scouting and inspection. Most of the abandoned seedling plantings had been removed and commercial plantings made easier to inspect by pruning and removal of offshoots. The improved conditions made it possible to intensify inspection and scouting, and to carry on systematic inspection of fan palms and other possible hosts of *Parlatoria* scale in the infested areas. Some scouting was done outside the date-growing areas where date palms are grown as ornamentals. The number of infested palms found has been decreasing consistently as the work progresses.

Nearly half of the infested palms found in the various districts were dug out and destroyed. The remainder, with two exceptions, were either pruned, defoliated and torched, or defoliated and sprayed. In addition, 1,543 valueless seedling palms were dug out and destroyed in the infested area in the Coachella Valley. The details are shown in Table 20.

COACHELLA VALLEY

During the past year, 255,180 palm inspections were made, but no new infested properties were found. Seventy-seven infested date palms were found on 13 properties as against 494 infested palms on 27 properties found during the previous year. Fifteen infested palms were found on 3 properties during the last six months of the year as compared with 122 infested palms on 22 properties in a like period in the fiscal year 1930. In addition to the 77 infested date palms found in 1931, 44 fan palms in an ornamental date planting were found infested.

IMPERIAL VALLEY

A second survey of the Imperial Valley was made and no infested palms were found outside the area considered infested after the first survey. The number of palms inspected amounted to 51,390. During the fiscal year 1930, 92 infested palms were found on 30 properties, 11 of the properties representing new infestations. During the past year 57 infested palms were found on 14 properties, 7 of the properties representing new infestations.

PHOENIX DISTRICT

During the past year, 50,547 palms were inspected, but no new infested properties were found. Only 1 infested date palm was found as compared with 27 infested palms found on 5 properties during the

fiscal year 1930. In addition to the 1 infested date palm, 50 infested fan palms were found on property on which date palms had been previously found infested.

YUMA DISTRICT

During the past year, no new infested properties were found. Slightly more than 33,000 palm inspections were made. Two infested date palms were found on 2 properties as compared with 8 infested palms on 3 properties in 1930.

TABLE 20.—*Palm inspection and treatment, date-scale eradication project, fiscal year 1931*

Item	Arizona		California		Total
	Phoenix district	Yuma district	Coachella Valley district	Imperial Valley district	
Palm inspections.....	50, 547	33, 558	255, 180	51, 390	390, 675
New infested properties.....	0	0	0	7	7
Total infested properties.....	2	2	13	14	31
Date palms infested.....	1	2	77	57	137
Fan palms infested.....	50	0	44	1	95
Total.....	51	2	121	58	232
Treatment:					
Dug out and destroyed.....	50	1	30	35	116
Defoliated and torched.....	1	0	26	21	48
Defoliated and sprayed.....	0	1	44	0	45
Pruned.....	0	0	20	1	21
No treatment ¹	0	0	1	1	2
Valueless seedling palms dug out and destroyed in infested areas (not included above).....	0	0	1, 543	0	1, 543

¹ Single dead scales found.

QUARANTINE ON DOMESTIC NARCISSUS

A hearing was held in Washington, D. C., January 29 and 30, 1931, for the purpose of reviewing the pest situation with respect to narcissus bulbs and of considering the advisability of modifying the present restrictions on their entry from foreign countries and on their interstate movement. The evidence submitted at the hearing indicated that gratifying progress has been made in controlling pests in narcissus-bulb plantings and that the domestic narcissus quarantine contributed to such condition. On March 3 a press notice was released stating that there will be no relaxation in the regulations governing the admission of narcissus bulbs from abroad and that the domestic quarantine regulations on them will be more rigidly enforced.

Both the field and harvest inspections of narcissus bulbs are made by the inspection forces of the various States cooperating with the Plant Quarantine and Control Administration. The total number of bulbs inspected for the calendar year 1930 was 317,815,409, of which 120,436,416 were of the hardy daffodil type common in the Northern States, and 197,378,993 were of the Paper White or polyanthus type commonly grown in the South. These figures show an increase of 44,307,660 over the number for the previous year. A total of 292,224,512 bulbs was reported as having been certified for interstate movement, of which 200,803,124 were certified as uninfested, and 91,421,388 were treated. The details for the different States are

published in the Service and Regulatory Announcements of the administration. (S. R. A. No. 107, pp. 70 and 71.)

Lesser bulb flies were definitely reported as present in specified plantings in California, Illinois, Michigan, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Virginia, and Washington. Findings were reported during the 1929 calendar year but not during 1930 in Maryland and Minnesota. The lesser bulb fly has recently been discovered in Georgia and Tennessee. The greater narcissus bulb fly was definitely reported in California, New York, North Carolina, Ohio, Oregon, Virginia, and Washington. *Tylenchus dipsaci* infestations in the 1930 crop were reported definitely in Alabama, California, Georgia, Michigan, New York, Ohio, Oregon, Virginia, and Washington. In addition, this pest has been found in Florida, Indiana, North Carolina, and Tennessee during the spring field inspection of 1931. One infestation of *Aphelenchus subterraneus* was reported from Florida in the 1931 crop.

During the fiscal year, 259 shipments in violation of the narcissus bulb quarantine were intercepted by transit inspectors and other employees and collaborators of the administration. This is a decrease of 38 per cent from the number intercepted during the previous season. More detailed information concerning these interceptions is given in Tables 21 and 22, pages 52 and 53.

PHONY PEACH DISEASE

Under the amendment to the phony peach disease quarantine regulations, effective November 1, 1929, 7 counties in Alabama and 83 counties in Georgia were designated as regulated areas. Between that date and June 30, 1930, the disease was discovered in the following additional territory: Twelve counties in central Mississippi; near Monticello and Warren, Ark.; Monroe and Bastrop, La., and Winchester and Cleveland, Tenn.

A most important development was the discovery during the fall of infections in 6 counties in Texas, 1 county in North Carolina, and 10 counties in South Carolina, as well as additional infections in Arkansas, Louisiana, and Tennessee. During June, 1931, the disease was also found in 6 counties in northern Florida, and additional findings near Winchester, Tenn., were reported. The Florida findings involved two nurseries that had phony trees within 1 mile of the premises.

As a result of such findings of the disease as had been made up to that time, a hearing was held in Washington, on November 14, to consider the advisability of extending the quarantine to the States of Texas, Arkansas, Louisiana, Tennessee, North Carolina, South Carolina, and Mississippi. As an alternative to such extension the question of possible discontinuance of the quarantine was discussed. Since practically all the infections known to exist outside the areas under regulation were incipient and none of them seemed to involve risk of spreading the disease during the immediate future, quarantine action was withheld pending further investigations.

Steps were taken with the State officials concerned to obtain the prompt eradication of all known-infected trees located outside the regulated areas with the result that by the opening of the spring growing season nearly all such trees had been destroyed at the more outlying points of infection. The Bureau of Plant Industry, which is

cooperating with the States in such work, also reports considerable progress has been made in exterminating the disease in the regulated areas of northern Georgia and northeastern Alabama.

The responsibility of the Plant Quarantine and Control Administration with respect to the phony peach disease has been limited to that of preventing further spread by not permitting interstate shipments of host plants grown within 1 mile of infection.

The Federal quarantine regulations prohibit all interstate movement of peach and nectarine nursery stock, and any other stock budded or grafted on peach or nectarine roots, from the regulated area to outside points unless such stock has been produced in nurseries "within which, and within 1 mile of which, no infection of the phony peach disease has existed for at least two years prior to the proposed date of movement." Similar restrictions are placed on such shipments from the generally infected area to the lightly infected area, and State quarantines govern intrastate movement in a similar manner.

Six Georgia nurseries and one Alabama nursery were issued permits under these requirements and allowed to ship interstate to points outside the regulated areas during the fall, winter, and spring nursery stock-shipping seasons (1930-31). Similar permits were issued to seven dealers within the regulated areas to handle peach or nectarine stock not grown by themselves.

Concord, Ga., is a very important peach-nursery-stock shipping point and some blocks of restricted stock grown in that community were eligible for shipment under certification while others were not. In order to take care of this special situation it has been necessary for the administration to station an inspector at Concord throughout the last two shipping seasons. The duties of this inspector were primarily to certify shipments of approved stock offered for movement to points outside the generally infected area. Certificates covering 1,705 shipments were issued to the nurserymen located at Concord. These shipments were destined to points throughout all the Southern States and to other parts of the United States, some as far north as New York and as far west as Oklahoma.

The quarantine regulations were enforced primarily through the inspection of interstate shipments of nursery stock in transit at such important distribution points as Atlanta, Ga.; Birmingham, Ala.; and Nashville and Memphis, Tenn. Only two violations of the quarantine were intercepted during the fiscal year.

WOODGATE-RUST QUARANTINE

Woodgate rust is a parasitic fungous disease which was apparently introduced into New York State about 25 or 30 years ago. While field and laboratory experiments have indicated that practically all hard pines are susceptible to its attack, several important species (including red and pitch pines) have not yet been proved able to support the fungus long enough to harbor and disseminate the disease, and are therefore omitted from the list of restricted species.

The regulations of the quarantine apply at present to the following pines: Scotch, Canary Island, slash, Japanese red, Corsican, stone, western yellow, Monterey, loblolly, and Jersey pines. Interstate movement of such trees from the regulated area in New York which

includes the Counties of Clinton, Essex, Franklin, Hamilton, Herkimer, Jefferson, Lewis, Madison, Oneida, and St. Lawrence, is prohibited.

In its present range of distribution, the disease has attacked Scotch pines with especial virulence, causing galls on the trunks as well as on the branches, which eventually destroy the timber value of the tree. Since none of the pines now prohibited from movement is native to northeastern United States, it appears that, from the standpoint of economic loss, the real danger would lie in its spread to the native hard pine regions of the South and West. The fact that there is only one nursery in the regulated area handling any of the prohibited species of pines, indicates that the possibility of preventing spread of Woodgate rust through shipments of nursery stock is excellent. The nursery concerned has an agreement with New York State whereby all susceptible pines are to be distributed within the regulated area.

No violations of the quarantine have been reported.

BLACK STEM RUST QUARANTINE

Since May 1, 1919, a quarantine has been in effect restricting the interstate movement of certain species of *Berberis* and *Mahonia* plants from 35 Eastern, Southern, and Western States and the District of Columbia, into 13 North Central States which have been engaged in a barberry-eradication campaign for the protection of grain against black stem rust infection.

On June 9, a hearing to consider the advisability of revising the quarantine was held at Washington, and on June 24 such a revision was approved, to be effective August 1, 1931. A most important feature of the new regulations is the placing under quarantine of the 13 North Central States (the protected States) in addition to the 35 States and the District of Columbia now concerned.

Under the new restrictions, permits will be required for all shipments of barberry and *Mahonia* shipped into or between the 13 protected States, except that the Japanese barberry together with its horticultural varieties may be so shipped without permit or other requirement. No restrictions are placed by these regulations on the interstate movement of *Berberis* or *Mahonia* between the 35 Eastern, Southern, and Western States, in which barberry eradication is not being carried on, or into the District of Columbia.

Eight violations of the quarantine were intercepted by transit inspectors of the administration during the fiscal year.

According to the Bureau of Plant Industry, the protected States, in cooperation with that bureau, destroyed 168,781 barberry bushes, seedlings, and sprouts during the calendar year 1930, making a grand total of 18,312,780 such bushes, seedlings, and sprouts destroyed since the campaign was started in the spring of 1918.

WHITE-PINE BLISTER RUST QUARANTINE ENFORCEMENT

The blister-rust quarantine regulations designed to prevent the spread of that disease prohibit the interstate shipment of 5-leaved pines from infected to noninfected States; permit such pines to be moved from generally infected States to lightly infected States only if grown under specified conditions of sanitation, and prohibit interstate movement of currant and gooseberry plants from the infected States unless the plants are of resistant species and varieties, shipped

under such conditions of dormancy, defoliation, and chemical treatment that the shipments could not transmit blister-rust infection. Also, the interstate movement of the highly susceptible European black currant is prohibited except among 12 States in the Great Plains and southern sections of the country where 5-leaved pines are not native. These safeguards make Federal inspection of blister-rust host plants prior to shipment, unnecessary except with respect to certain nurseries which grow 5-leaved pines in the generally infected States. It is possible to determine compliance with the regulations by inspection of stock en route, with a smaller personnel and at greatly reduced cost. This particular phase of the work is discussed separately under the heading "Transit inspection."

Nurseries desiring to ship 5-leaved pines from such generally infected States as the New England States, New York, Washington, Oregon, or Idaho, into more lightly infected States, are required to grow the trees from seed in a location within 1 mile of which there have existed no European black currant plants and within 1,500 feet of which there have existed prior to planting of such seed no gooseberry plants of any size or variety which in the judgment of the inspector would involve risk of spread of the white-pine blister rust. Three nurseries held permits during the fiscal year under these requirements—one in Maine, one in Vermont, and one in New York. For the next fiscal year applications have been received from seven nurseries in the New England States and one in New York. Federal inspections of the premises of these nurseries were made during May and June to determine the freedom of the nurseries and environs from blister rust and from currant and gooseberry plants. By the close of the fiscal year one tract in Connecticut, on which a nurseryman desired to plant 5-leaved pine seeds, was tentatively approved. Action with respect to the remaining applications was still pending on June 30.

Shipments of nursery stock moving by mail, express, or freight, to the number of 248, were intercepted by transit inspectors during the year as moving in violation of the blister rust quarantine regulations. The shipments in practically all cases were returned to the consignors.

TRANSIT INSPECTION

An important development in the enforcement of the various domestic quarantines is the establishment of a coordinated system of transit inspection. This type of work consists of inspecting materials of which the interstate movement is restricted by quarantines at points where shipments transported by the common carriers are concentrated and redistributed. It was started in 1920 by the Office of Blister Rust Control, Bureau of Plant Industry, in cooperation with the Federal Horticultural Board for the purpose of determining whether the provisions of the white-pine blister rust quarantine were being complied with. The results of such transit inspection work during that and following years proved conclusively that transit inspection constitutes an important "second line of defense" in the enforcement of domestic quarantines and in preventing the spread of pests. As a result, transit inspection was established by Congress as a separate project beginning July 1, 1930. To carry on its activities, \$40,000 was made available for the year.

It will be seen from the considerable number of violations of the various quarantines (2,394 as reported in Table 21), that this method of enforcement is proving of material assistance. Details showing

TABLE 21.—*Summary of shipments of nursery stock and other articles intercepted in violation of Federal plant quarantines at transit inspection points, fiscal year 1931—Continued*

Station	Quarantine No. 62		Quarantine No. 63		Quarantine No. 64		Quarantine No. 67		Quarantine No. 68		Total	
	Commercial shipments	Noncommercial shipments	Commercial shipments	Noncommercial shipments	Commercial shipments	Noncommercial shipments	Commercial shipments	Noncommercial shipments	Commercial shipments	Noncommercial shipments	Commercial shipments	Noncommercial shipments
New York.....	48	2	4	23						1	307	514
Ogden.....		1	2	1							2	2
Omaha.....		11	3	7							5	30
Philadelphia.....			3								60	27
Pittsburgh.....			2	1							24	14
Portland.....	21	9	10	5							35	16
Providence.....											1	0
St. Louis.....	7	4	1			3					18	19
St. Paul.....	2	1	17	11							22	16
Seattle.....	3	10	1	8							4	26
Spokane.....	6	4	1	1							8	5
Springfield.....				1							2	43
Washington.....				1							6	10
Total.....	165	94	127	121	1	7	1	1	1	10	1,083	1,311
Grand total.....												1 2,394

¹ The total number of quarantine violations shown here, 2,394, represents 2,311 different shipments; 83 were violations of two or more quarantines.

TABLE 22.—*Shipments of nursery stock and other plants and plant products inspected in transit fiscal year 1931*

Station	Packages				Trucks	Carloads of nursery stock and livestock cars
	Parcel post	Express	Freight	Total		
Albany.....	70	77	5	152		
Atlanta.....	356	2,359	0	2,715		
Baltimore.....	511	759	81	1,351		
Birmingham.....	3,305	3,812	88	7,205		
Boston.....	44,975	75,731	689	121,395		
Chicago.....	284,151	32,422	10,187	326,760	868	401
Cincinnati.....	2,472	1,942	163	4,577		
Denver.....	4,879	1,549	118	6,546		
Fitchburg, Mass.....		261	40	301		
Indianapolis.....	144	523	16	683	1,135	6
Kansas City.....	37,117	6,842	487	44,446		
Memphis.....	612	3,718	105	4,435		
Nashua, N. H.....		90	24	114		
Nashville.....	339	820	134	1,293		
New York.....	159,013	32,330	1,327	192,670		15
Ogden.....	2,832	1,768	190	4,790		
Omaha and Council Bluffs.....	23,509	10,046	306	33,861		
Philadelphia.....	80,750	18,555	299	99,604		
Pittsburgh.....	24,167	12,524	606	37,297		2
Portland.....	26,532	8,913	2,074	37,519		
Providence.....	36	117	0	153		
Rieth, Oreg.....			46	46		
St. Louis.....	10,685	8,493	1,689	20,867		17
St. Paul and Minneapolis.....	41,248	13,490	4,422	59,160		42
Seattle.....	18,465	2,917	668	22,050		2
Spokane.....	29,231	4,075	761	34,067		1
Springfield.....	17,224	2,638	0	19,862		
Washington, D. C.....	3,138	3,262	75	6,475		
Total.....	815,761	250,033	24,600	1,090,394	2,003	486

FOREIGN-PLANT QUARANTINES

The various foreign-plant quarantines and regulatory orders of the department are enforced by inspectors or collaborators of the Plant Quarantine and Control Administration stationed at the more important ports of entry and at foreign mail-distributing points where the work is conducted in close cooperation with the Treasury, Labor, Post Office, and State Departments. Since descriptive matter relating to the various foreign quarantines and regulatory orders enforced by the administration is available elsewhere, these quarantines are not discussed in this report except in the summary of revisions and revocations of quarantines and miscellaneous regulations given on pages 96 to 99. A record of the inspection work performed and of the plant contraband and pests intercepted at the various ports of entry and elsewhere in the United States in the enforcement of foreign quarantines follows.

PLANT-QUARANTINE INSPECTION

The enforcement of foreign plant quarantines and regulatory orders at maritime, interior, and Mexican-border ports of entry involves: (1) The inspection of vessels and aircraft arriving at ports of entry from foreign ports and from Porto Rico and Hawaii; (2) the inspection and disposition of restricted plants and plant products found by customs or immigration officials or by inspectors of the administration in the baggage of persons entering the United States from foreign countries and from Porto Rico or Hawaii; (3) the inspection of plants and plant products, including nursery stock, seeds, bulbs, fruits, and vegetables entered under permit from foreign countries and localities, and certain products arriving from domestic territory; (4) supervision of the disinfection (fumigation or sterilization) of cotton, cotton bagging, broomcorn, and other products requiring such treatment as a condition of entry; (5) inspection, through cooperation with customs and post office officials, of restricted plants and plant products arriving by foreign parcel post; (6) inspection of plants and plant products introduced by the Department of Agriculture and all plants imported under special permit in accordance with the provisions of regulation 14, quarantine No. 37; (7) field inspection of plants imported under special permit and grown under agreement; (8) inspection of domestic plants entering and leaving the District of Columbia; (9) inspection of plant-introduction gardens of the Bureau of Plant Industry; and (10) inspection of fruits and vegetables in the field and at the point of shipment in Porto Rico and Hawaii in accordance with the provisions of quarantines Nos. 58 and 13, respectively. In addition, this service inspects and certifies export fruits and vegetables to meet the sanitary requirements of certain foreign countries, and at certain ports assists flour exporters by inspecting the holds of vessels and warehouses for the presence of stored-grain insects.

While more than twice as many airplanes from foreign countries were inspected by collaborators and inspectors of the administration for the fiscal year 1930 as were inspected during the fiscal year 1929, there was a decrease in the number of airplanes inspected during the past year as compared to the preceding year. Notwithstanding this decrease, however, 445 airplanes were found to have brought in contraband plant material as compared to 400 planes bringing in such material in the fiscal year 1930. Among the airplane inter-

ceptions were such destructive insect pests as the citrus black fly, fruit-fly maggots, and at least seven different species of scale insects.

MEXICAN-BORDER SERVICE

Plant-quarantine inspectors are now stationed at 20 ports of entry along the Mexican border, the port of Sasabe, Ariz., having been added during the fiscal year. Lengthening of the hours during which a number of international bridges are open has made it necessary to increase the personnel. At the close of the fiscal year 79 inspectors were stationed on the Mexican border.

Rail connections with Mexico at Presidio, Tex., were completed on November 1, 1930, making eight ports along the border where railway cars are inspected and fumigated. A 6-car fumigation house is now under construction at Presidio. The movement of railway cars across the border from Mexico showed a considerable decrease during the fiscal year. Thirty-four thousand one hundred and fifty-eight freight cars were inspected in the Mexican railway yards. Of these, 32,231 entered the United States and 10,729 were fumigated as a condition of entry. One thousand five hundred and eight were found to be contaminated with cottonseed and required to be cleaned before entry was permitted. A charge of \$4 was made for each car fumigated and all fees collected were covered into the Treasury as miscellaneous receipts.

A summary of the railway-car inspection and fumigation is given in Table 23.

TABLE 23.—*Inspection and fumigation of railway cars crossing the border from Mexico, fiscal year 1931*

Port	Cars inspected	Cars with cottonseed	Cars entered	Cars fumigated	Fees collected
Brownsville.....	217	19	211	139	\$556
Douglas ¹	783	26	783	64	256
Eagle Pass.....	2,535	444	2,305	1,575	6,100
El Paso.....	10,878	110	10,543	1,204	4,856
Laredo.....	9,353	718	8,276	5,792	22,800
Naco.....	1,107	5	1,107	35	140
Nogales.....	9,250	182	8,971	1,913	7,600
Presidio ²	35	4	35	7	28
Total.....	34,158	1,508	32,231	10,729	³ 42,336

¹ Does not include 1,016 Mexican gondolas which crossed to the smelter, unloaded, and returned to Mexico.

² The records cover only the period Nov. 1, 1930, to June 30, 1931, of the fiscal year 1931.

³ The apparent discrepancy in fees collected and the number of cars fumigated may be explained by the fact that it is customary for the railroads to purchase fumigation coupons in advance.

In addition to the freight cars listed in Table 23, 4,363 Pullman and passenger coaches crossing the border were inspected. Inspectors of the administration cooperate with the Customs Service and take an active part in the inspection of vehicles, baggage, personal effects, and express packages from Mexico, and assist the Customs Service and Post Office Department in the inspection of foreign parcel-post packages. During the year 90,953 pieces of baggage and 956 parcel-post packages were examined.

A list of the more important interceptions of prohibited plants and plant products is included in Table 24.

Commodity	Fabens		Hidalgo		Laredo		Mercedes		Naco		Nogales		Presidio	
	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹
Apples.....	21	54	239	724	626	2,330	50	130	128	313	432	1,366	61	540
Apricots.....	.....	.....	5	91	25	327	1	13	1	2	39	336	3	48
Avocados.....	.....	.....	56	246	364	2,776	10	54	.....	.....	88	289	3	9
Avocado seed.....	.....	.....	46	94	128	391	6	19	9	18	27	95	1	1
Cherimoyas.....	.....	.....	6	8	32	55	.....	.....	.....	.....	3	3	.....	.....
Corn (ears).....	33	89	.....	.....	.....	.....	102	519	26	107	.....	.....	16	57
Corn (pounds).....	56	9	96	707	124	412	30	5,153	40	125	113	524	1	168
Cotton bolls.....	6	18	61	278	13	41	40	109	23	6	6	23	49	417
Cotton lint (pounds).....	53	100	2	53	14	71	33	93	7	12	39	28	3	1
Cottonseed (pounds).....	58	11	12	37	25	20	19	13	3	5	2	1	.....	.....
Seed cotton (pounds).....	95	20	35	47	31	12	.....	.....	.....	.....	.....	.....	66	20
Dates.....	.....	.....	2	26	4	198	1	2	.....	.....	38	3,094	.....	105
Figs.....	.....	.....	13	443	86	1,069	.....	.....	4	49	51	766	5	.....
Grapefruit.....	1	2	163	403	48	180	66	179	8	29	37	124	1	1
Guavas.....	1	1	4	8	161	828	.....	.....	2	3	9	38	2	15
Kumquats.....	.....	.....	2	12	.....	.....	2	6	.....	.....	.....	.....	.....	.....
Mangos.....	.....	.....	27	51	87	153	.....	.....	11	16	4	6	1	7
Oranges.....	17	51	7	18	205	540	.....	.....	106	220	59	201	49	246
Papayas.....	.....	.....	459	1,279	1,412	5,809	141	390	.....	.....	12	26	.....	.....
Peaches.....	7	25	32	149	99	255	11	14	40	294	184	1,136	9	207
Pears.....	5	32	31	95	164	927	2	6	40	54	100	426	10	40
Plants.....	36	341	197	2,154	702	3,183	65	734	30	211	183	1,568	38	286
Plums.....	1	13	5	28	39	300	3	36	11	86	47	505	3	141
Pomegranates.....	.....	.....	37	136	179	857	4	5	3	8	104	227	10	37
Potatoes.....	12	89	77	1,209	99	890	48	229	.....	.....	.....	.....	32	4,232
Quinces.....	1	2	32	63	176	513	6	16	31	60	152	266	6	48
Sapotes.....	.....	.....	12	102	17	52	.....	.....	.....	.....	.....	.....	.....	.....
Sugarcane.....	12	7	21	102	112	406	3	9	8	9	100	252	4	22
Sweet limes.....	.....	.....	.....	.....	71	409	.....	.....	20	56	96	319	.....	.....
Sweet potatoes.....	2	23	6	18	37	217	2	4	7	31	43	233	6	24
Tangerines.....	.....	.....	80	332	45	204	16	67	1	12	11	53	4	4

¹ Expressed in numbers of fruits, plants, etc.

TABLE 24.—*Contraband plants and plant products intercepted at Mexican border ports, fiscal year 1931—Continued*

Commodity	Rio Grande City		Roma		San Ysidro		Sasabe ²		Ysleta		Zapata		Total	
	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹	Intercep- tions	Quan- tity ¹
Apples.....	2	5	82	154	1,034	6,344	27	77	31	132	25	90	4,913	19,224
Apricots.....	2	24	10	30	101	2,289	2	89	3	36			275	5,095
Avocados.....	2	2	11	24	113	361			1	361	4	6	1,428	6,169
Avocado seed.....					6	28			1	2			336	995
Cherimoyas.....					1								81	127
Corn (ears).....	11	58	44	281	49	622			16	622			806	5,893
Corn (pounds).....	2	13	39	55			1	2	28	27	51	225	877	14,804
Cotton bolls.....	7	68			14	149			11	119			431	2,246
Cotton lint (pounds).....	1	1	3	3			1	5	13	2	21	49	318	480
Cottonseed (pounds).....	4	2	82	177			1	1	25	2	18	45	316	417
Seed cotton (pounds).....							1		54	13			340	132
Dates.....	1	200	2	229									127	6,107
Figs.....			2	31	44	776	5	778	1	4			508	16,336
Grapefruit.....			2	2	291	1,557	7	12	1	1	2	3	924	3,403
Guavas.....	1	15	4	10	3	32							340	1,645
Kumquats.....					2	45							14	116
Mameys.....													185	319
Mangoes.....	2	9	79	153	14	63			1	2			721	1,963
Oranges.....	5	31			2,241	25,629	75	493	26	119	30	117	8,361	49,184
Papayas.....													28	50
Peaches.....	2	23	9	32	217	2,113			7	30	6	20	1,032	6,295
Pears.....	1	5	3	10	253	1,614	3	206	7	17	4	16	983	3,968
Plums.....	16	124	165	914	249	2,289	15	55	21	114	33	373	3,127	21,463
Pomegranates.....			2	13	116	1,627	1	6	3	957	1	1	364	5,347
Potatoes.....	6	17	10	26	10	59			1	1	3	4	537	1,947
Quinces.....			4	165	126	2,395			8	61	20	439	915	15,093
Sapotes.....	1	6			4	36			1	1			675	1,961
Sugar cane.....									1	1			114	242
Sweet limes.....	25	82	32	86	25	100	2	9	3	5	3	35	808	2,167
Sweet potatoes.....			1	5	11	149	9	63	1	2	2	28	294	1,463
Tangerines.....					101	1,629			8	26	1	1	364	2,287
														2,951

¹ Expressed in numbers of fruits, plants, etc.² Inspector stationed at Sasabe Feb. 10, 1931.

The importation of fresh fruits and vegetables from Mexico decreased considerably during the past year. A total of 6,016 cars were imported, practically all through the port of Nogales, Ariz. Three thousand two hundred and eighty-two cars of bananas were imported, the bulk of the movement being through El Paso. In addition considerable quantities of certain fruits and vegetables were entered for local consumption under permits issued to the inspectors in charge at the various ports.

MARITIME-PORT INSPECTION

SHIP INSPECTION

The ship inspection has been continued along the lines described in previous annual reports. Ships from foreign ports as well as those from Hawaii and Porto Rico are inspected upon arrival for the presence of prohibited plants and plant products in stores, passengers' and crews' baggage and quarters, and in cargo.

The ports of Gulfport, Miss., Wilmington, N. C., and Buffalo, N. Y., were added to the list at which the administration has representatives. The personnel at some of the other ports was also considerably strengthened.

The inspection at ports in California, Florida, Hawaii, and certain ports in Porto Rico is performed by State and Territorial officials serving as collaborators of the Plant Quarantine and Control Administration at a very small cost to the department.

A record, by ports, of the number of ship arrivals, ship inspections, and ships carrying contraband plants and plant products appears in Table 25.

TABLE 25.—*Ships inspected, fiscal year 1931*

Port	From foreign ports						From Hawaii			From Porto Rico					
	Direct			Via Hawaii			Via Porto Rico			Via United States ports			Direct		
	Arrived	Inspected	With con- triband	Arrived	Inspected	With con- triband	Arrived	Inspected	With con- triband	Arrived	Inspected	With con- triband	Arrived	Inspected	With con- triband
Astoria 1.....	26	25	23							21	20	10	0	0	0
Baltimore.....	726	707	456							788	770	347	0	0	17
Bellingham.....	353	61	20							15	8	2	0	0	0
Boston.....	1,268	1,089	536							283	256	85	0	0	0
Brunswick, Ga. 2.....	12	8	7							0	0	0	0	0	0
Charleston.....	156	156	124							151	151	54	0	0	0
Galveston.....	312	312	273							564	549	189	0	0	3
Gulport.....	33	33	28							92	83	32	0	0	2
Honolulu 3.....	226	226	109							72	72	0	0	0	0
Houston.....	222	222	36							612	612	10	0	0	0
Jacksonville 3.....	162	162	120							138	138	78	0	0	0
Key West 3.....	701	701	262							0	0	0	0	0	0
Miami 3.....	790	790	336							5	5	1	0	0	0
Mobile.....	232	232	99							375	375	47	0	0	0
Newport News 3.....	72	27	23							434	38	38	0	0	1
New Orleans.....	1,462	1,462	1,015							910	351	178	0	0	0
New York.....	4,429	3,753	2,270							1,162	982	405	0	0	0
Norfolk.....	389	382	181							1,163	1,048	401	0	0	0
Pensacola 3.....	60	60	16							180	180	1	0	0	2
Philadelphia.....	978	951	600							991	952	565	0	0	0
Port Arthur 4.....	193	193	61							186	185	178	0	0	1
Portland, Ore.....	105	105	70							424	424	12	0	0	4
Porto Rico (all ports).....	1,178	1,178	723							0	0	0	0	0	0
Providence 5.....	105	16	16							15	0	0	0	0	0
San Diego 3.....	1,417	1,417	42							92	90	0	0	0	0
San Francisco 3.....	629	629	98							1,092	1,092	64	0	0	0
San Pedro 3.....	2,219	2,219	226							507	507	26	0	0	0
Savannah.....	104	104	72							75	61	33	0	0	0

Seattle.....	1,884	936	189	1	1	0	0	0	383	267	1	6	6	2	14	14	0	0	0	0	0	0	0	0	0
Tampa.....	320	320	76	0	0	0	0	0	290	290	4	0	0	0	0	0	0	0	5	1	4	4	1	1	0
Wilmington, N. C. ⁶	33	33	1	0	0	0	0	0	32	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total.....	20,796	18,509	8,108	241	241	130	145	139	94	11,052	9,537	2,761	335	335	71	50	48	2	357	341	212	125	119	31	31

¹ The records cover only the period July 1 to Mar. 16 of the fiscal year 1931.

² Work handled by inspector stationed at Savannah, Ga.

³ Collaborators are stationed at these ports.

⁴ Includes ships arriving at Beaumont and Sabine, Tex., and Lake Charles, La.

⁵ Work handled by inspectors stationed at Boston, Mass.

⁶ Inspector stationed at Wilmington Oct. 1, 1930.

NOTE.—The foreign ship arrivals do not in all cases agree with customs figures. Foreign ships may put in for bunkers and be inspected by inspectors of the Plant Quarantine and Control Administration but not entered by customs. On the other hand, boats entered at certain small outside ports are included in customs records but not in this report.

CARGO INSPECTION

All importations of plants and plant products subject to quarantine restrictions (with the exception of plant material imported under regulation 14 of quarantine No. 37, which was examined in Washington, D. C., or San Francisco, Calif.), were inspected at port of entry or port of first arrival.

Table 26 indicates, by port, the number of shipments inspected and entered under permit and the number of shipments refused entry.

TABLE 26.—*Inspection of shipments of plants and plant products offered for entry, fiscal year 1931*

Port	Shipments inspected and entered under permit	Shipments refused entry	Port	Shipments inspected and entered under permit	Shipments refused entry
Baltimore.....	310	0	New Orleans.....	2, 120	7
Bellingham.....	90	0	New York.....	13, 694	24
Boston.....	1, 129	1	Norfolk.....	252	2
Buffalo.....	280	1	Philadelphia.....	690	15
Charleston.....	83	0	Portland, Oreg.....	59	0
Chicago.....	80	2	Porto Rico (all ports).....	871	0
Detroit.....	311	18	Providence.....	44	0
Galveston.....	234	2	San Diego ¹	7	1
Houston.....	166	1	San Francisco ¹	1, 632	2
Honolulu ¹	515	116	San Pedro ¹	616	21
Jacksonville ¹	25	0	Savannah.....	89	1
Key West ¹	1, 411	0	Seattle.....	571	1
Miami ¹	74	0	Tampa ¹	929	1
Mobile.....	146	0	Total.....	26, 428	216

¹ Collaborators are stationed at these ports.

NOTE.—The records do not include shipments arriving under "in transit" entries which were inspected at port of first arrival.

Certain commodities require disinfection in addition to inspection as a condition of entry. Such treatment is given under the supervision of administration inspectors at commercially operated plants. The following plant material requiring treatment was imported during the year: Cotton, 93,674 bales (including 1,642 bales of lintners) and 519 packages; cotton waste, 10,246 bales and 49 packages; bagging, 2,882 bales; broomcorn, 62 bales; tree seeds, 14,905 pounds and 302 packages; nursery stock, 58 cases; chestnuts, 11,562 cases; and narcissus bulbs imported under special permit, 6,973,136. Samples of cotton, cotton waste, and lintners arriving by parcel post are also treated under similar supervision at commercial and Federal plants. During the year 436 such parcels were treated at approved ports other than Washington, D. C.

Considerable time was devoted at several ports to inspection of miscellaneous cargoes requiring examination to establish the true status of the material. Some time was also spent in supervising the cleaning by importers of products contaminated with objectionable material such as soil.

Inspection of ships' holds and docks for the presence of insects injurious to flour were made at several southern ports. At Galveston 53 ship inspections were made during the year; at Houston 65 ship and 71 dock inspections; at Jacksonville 2 ship inspections; at Mobile 6 ship and 15 dock inspections; at New Orleans 224 ship and 86 dock inspections; and at Port Arthur 5 ship inspections.

INSPECTION OF SPECIAL PERMIT AND DEPARTMENTAL PLANT MATERIAL

As in previous years, all plants imported under special permit have been inspected either at Washington, D. C., or at San Francisco, Calif. A tabular record of such importations is given on pages 81 to 84. All departmental importations and distributions from Washington, including domestic plants entering and leaving the District of Columbia, are likewise inspected and certified for shipment at the inspection house or in the nursery, freight, express, or post offices. A summary of this work is given in Table 27.

TABLE 27.—*Summary of plants and plant products offered for inspection in the District of Columbia, fiscal year 1931*

Material inspected	For- eign	Domes- tic	Fumi- gated	Other- wise treated	Infest- ed with insects	Infest- ed with diseases
Lots of seeds (departmental).....	6, 314	5, 531	8, 961	1, 892	207	90
Plants, cuttings, bulbs, roots, rhizomes, etc. (depart- mental).....	33, 532	164, 748	16, 269	24, 792	1 372	1 163
Miscellaneous unclassified material, other than plants and seeds (departmental).....	193	97	141	95	1	2
Shipments of plants under regulation 14, quarantine 37 (commercial).....	1, 160	-----	129	114	222	249
Shipments of plants and plant products under regula- tions 3 and 15, quarantine 37 (commercial).....	731	-----	490	77	28	30
Containers of domestic plants other than departmental (mail, express, freight, and truck).....	-----	17, 991	-----	-----	-----	-----
Shipments of plants for distribution by United States Botanic Garden.....	-----	4, 893	-----	4, 893	102	15
Shipments of plants by private individuals.....	-----	1, 144	9	33	34	27
Interceptions of plants and plant products referred to Washington.....	1, 100	-----	385	222	58	19
Cotton samples referred to Washington.....	12, 976	-----	12, 976	-----	-----	-----

¹ Lots.

FIELD INSPECTION OF PLANTS IMPORTED UNDER SPECIAL PERMIT

Plants imported under regulation 14, quarantine No. 37, in limited quantities for the purposes of keeping the country supplied with new, improved, or unavailable varieties and necessary propagating stock, or for experimental, educational, or scientific purposes are grown in 46 States under the observation of the department. It is necessary to inspect these plants in the field to determine: (1) Freedom from important pests, particularly plant diseases, which may have escaped detection or which were in such an early stage of development as to make it impossible to recognize them at the initial inspection at the port designated in the permit, prior to shipment to the field; and (2) the rapidity of propagation and the probable date at which the plants will be available in this country in sufficient quantities to make it unnecessary to continue to accept the pest risk which accompanies importations of the kind of plants involved.

During the year 662 man-days were spent in examining special-permit material grown by 889 permittees, located in 582 towns in 37 States. Inspections were made involving 30,333,987 plants, bulbs, etc., imported under 3,535 special permits, classified as follows: Dahlia, 34,667; gladiolus, 1,989,175; iris, bulbous, 10,539,741; iris, rhizomatous, 37,820; narcissus, 13,380,904; orchid, 47,759; peony, 179,184; rose, 152,474; fruit, 1,449; herbaceous, 536,626; ornamental, 999,247; miscellaneous bulbs, roots, etc., 2,434,941. As a result of these inspections plant material was released involving 1,609 special-permit importations. All this material was apparently free of plant

pests likely to become established in this country. This plant material involved, with the increase produced over a period of two or more years, 16,321,798 plants, bulbs, etc.

During the fiscal year 651 collections of plant pests were sent in for verification and determination, 460 of which were diseases and 191 insects. Among the more important or little known pests found were the following: Nematodes—*Aphelenchus parietinus*, *Tylenchus dipsaci* (bulb and stem eelworm) in narcissus and bulbous iris and *Paraphelenchus pseudoparietinus* in narcissus; diseases—*Bacterium delphinii* (black spot) on leaves of delphinium, *Cytospora ambiens* on stems of lilac, *C. leucosperma* on stems of holly, *Diaporthe rudis* (a canker organism) on stems of Cytisus, Genista, and Laburnum, and also its imperfect stage, *Phomopsis rudis*, on Caragana, *Mycosphaerella weigeliae* (leaf spot) on leaves of Diervilla, *Oidium* sp. (powdery mildew) on leaves and stems of varieties of *Hydrangea hortensis*, *Phoma syringa* on stems of lilac, *Phomopsis incarcerationata* on stems and roots of rose (said to be the first report for the United States), *Phyllosticta camelliae* (leaf spot) on camellias; insects—*Aeolus* sp. (Elateridae) in bulbous iris, *Aspidiotus* sp. (Coccidae) on leaves of rhododendron, *Dolopius* sp. (Elateridae) in bulbs of narcissus, *Eumerus* sp. (Syrphidae) in bulbs of narcissus and iris, *E. tuberculatus* (Syrphidae) in bulbs of narcissus, *Fenusa pumila* (birch leaf miner) on birch, *Histiostoma* sp. (mite) in bulbs of iris, *Melanotus* sp. (Elateridae) in stem of bulbous iris, *Merodon* sp. (Syrphidae) in narcissus, *M. equestris* (narcissus fly) in narcissus, *Mordella* sp. (Mordellidae) in stems of Prunus, and *Papaipema* sp. (Noctuidae) in stem of deutzia.

FOREIGN PARCEL-POST INSPECTION

Inspection of foreign parcel-post packages is performed in cooperation with the customs and post-office officials. All packages from foreign countries that are found to contain plants or plant products are referred to an inspector of the administration for examination. Foreign parcel-post packages containing plants or plant products arriving at ports where there are no representatives of the administration are forwarded by the postal officials to the nearest port at which an inspector is stationed.

Table 28 indicates by port the number and disposition of foreign parcel-post packages containing plants and plant products that were inspected during the year.

TABLE 28.—Number of inspections of foreign parcel-post packages, fiscal year 1931

Port	In-spected	Refused entry (entire or in part)	Diverted to Washington	Port	In-spected	Refused entry (entire or in part)	Diverted to Washington
Baltimore.....	217	49	95	New Orleans.....	56	21	31
Boston.....	863	94	523	New York.....	1,647	805	807
Buffalo.....	18	0	17	Philadelphia.....	6,941	429	613
Chicago.....	1,103	428	56	Portland, Oreg.....	43	10	9
Detroit.....	4,370	256	230	Porto Rico (all ports).....	28	0	0
Honolulu ¹	1,553	85	0	San Diego ¹	41	1	1
Jacksonville ¹	461	54	41	San Francisco ¹	1,618	145	0
Los Angeles ^{1,2}	2,971	204	0	Seattle.....	167	90	13
Miami ¹	30	19	11				
Mobile.....	35	6	14	Total.....	22,162	2,696	2,461

¹ Collaborators are stationed at these ports.

² 71 packages were diverted to San Francisco for treatment.

INSPECTION IN PORTO RICO AND HAWAII

Aside from the inspection of ships and plants and plant products arriving in Porto Rico from foreign countries, the inspectors stationed on that island enforce the provisions of quarantine No. 58, and inspect parcel-post packages originating in Porto Rico and destined for the mainland. Valuable assistance is rendered in the enforcement of the foreign-plant quarantines by insular plant-quarantine inspectors serving as collaborators.

During the fiscal year under consideration 513 parcel-post packages originating in Porto Rico were examined in cooperation with the post-office officials and 58 were found to contain contraband-plant material.

In the enforcement of quarantine No. 58 inspection of fruits and vegetables has been carried on in the fields, packing houses, and on the docks, and all shipments moving to the mainland have been certified as free from pests. Table 29 shows, by months, the number of containers of fruits and vegetables inspected and certified for shipment.

TABLE 29.—Number of containers of fruits and vegetables moving from Porto Rico to the mainland, inspected and certified under Quarantine No. 58, fiscal year 1931

Item	Inspected and certified during—											
	July	August	September	October	November	December	January	February	March	April	May	June
Achiotos.....									2			
Avocados.....	38	70	124			1						
Bananas (bunches).....	5,130	28	479	551	313	248	84	1		7	8	33
Cacao pods.....								39	10			
Chayotes.....	10		4	36	98	50		1				
Citrons.....			1	6				1				
Cucumbers.....	34	21	14	40	111	1,767	2,171	150	77	15	2	44
Dashiens.....								45	34	65	10	
Eggplants.....						48	621	1,242	773	172	151	65
Ginger.....	12	100	4		20	1	15	1	3	2		
Grapefruit.....	31,352	14,702	54,446	32,167	16,057	1,372	4,040	6,620	36,889	49,033	58,143	132,304
Lemons.....		40			3	17	5					2
Lima beans.....								14	6			
Limes.....	19		4	4		10		1		2		43
Malangas.....	13				22	10		5	10		15	
Mixed fruit.....		1	1	7	12	161	9	5	13	9		4
Oranges.....		161	4,151	45,501	12,611	915	6,146	5,554	10,939	7,311	2,344	1,344
Oranges, bitter.....						405						
Peppers.....					439	2,635	5,137	3,617	1,622	3,558	1,034	104
Pigeon peas.....							15	28	44	33	25	15
Pineapples.....	26,523	11,200	12,474	6,265	3,506	9,237	7,648	28,935	49,985	205,227	241,662	100,448
Plantains.....	20		4		1		2		1			
Potatoes.....							101	394	163			
Pumpkins.....	27	37	26	170	28	20	139	229	63	74	120	20
Sesame.....							1					
Sour limes.....		24										1
String beans.....							33					24
Squash.....				9	55	219	484	61	77	25	4	114
Tamarinds.....									128			981
Tangerines.....						37	84		3		18	21
Taniers.....					201		1		43			121
Tomatoes.....						1,814	1,067	1,930	25	1	7	44
Watermelons.....						5	51	128	32	2	7	5,045
Yucas.....	2											225
Total.....	63,181	26,384	71,732	84,772	33,478	18,972	27,893	49,001	100,942	265,587	303,596	1,279,920
Certificates.....	285	184	238	311	361	265	331	272	353	515	681	580

The work in Hawaii is principally the enforcement of quarantine No. 13, on account of the Mediterranean fruit fly and melon fly, and consists of the inspection and certification of such fruits and vegetables as are permitted to move to the mainland.

Arrangements were also made during the year for the inspection in Hawaii of parcel-post packages destined for points on the mainland. Heretofore this inspection had been performed at ports of entry on the mainland. The parcel-post inspection was commenced on November 1, 1930, and during the 8-month period between that date and June 30, 1931, 134,143 packages were examined in cooperation with the post-office officials and 118 were found to contain contraband plant material. A summary of the fruits and vegetables inspected and certified for shipment to the mainland appears in Table 30.

TABLE 30.—*Number of containers of fruits and vegetables inspected and certified for shipment from Hawaii to the mainland, fiscal year 1931*

Month	Bananas ¹	Pine-apples	Taro	Coconuts	Ginger root	Lily root	Permits issued
July.....	9,097	1,344	575	30	20	257	229
August.....	8,477	838	439	90	5	190	181
September.....	7,637	673	376	265	4	254	139
October.....	13,634	779	581	319	332	314	166
November.....	10,703	1,537	120	9	16	190	152
December.....	13,099	1,317	114	183	366	394	177
January.....	20,314	1,298	65	349	72	274	185
February.....	9,108	1,668	33	185	92	308	161
March.....	8,924	584	3	34	106	148	109
April.....	8,867	653	29	29	108	155	108
May.....	10,811	1,571	10	32	35	278	226
June.....	9,066	2,209	62	71	53	187	150
Total.....	129,737	14,471	2,407	1,596	1,209	2,949	1,983

¹ Bunches.

As an accommodation to travelers between Hawaii and the mainland, baggage is inspected and sealed in Honolulu, thus eliminating delay incident to the inspection of baggage at destination. During the fiscal year 2,120 pieces of baggage were inspected and sealed.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

As heretofore, plants for distribution by the Bureau of Plant Industry from its plant-introduction and propagating gardens were inspected and certified prior to shipment. Plants shipped from Mandan, N. Dak., and Chico, Calif., were inspected by officials of the States concerned serving as collaborators of the administration. Those distributed from Chapman Field, Fla., and Savannah, Ga., were examined by inspectors of the administration in cooperation with officials of the States of Florida and Georgia, likewise serving as collaborators. Table 31 indicates the number of plants inspected and certified for distribution.

TABLE 31.—*Number of plants, bud sticks, cuttings, tubers, roots, and shipments of seeds examined for distribution from plant-introduction and propagating gardens, fiscal year 1931*

Station	Plants	Bud sticks, cuttings, tubers, and roots	Shipments of seeds
Bell.....	29, 223	1, 554	2
Chico.....	27, 813	3, 944	143
Chapman Field.....	2, 412	180	75
Savannah.....	11, 075	1, 108	16
District of Columbia.....	7, 585	31, 971	12, 818
Mandan, N. Dak.....	249, 474		
Total.....	327, 582	38, 757	13, 054

PESTS INTERCEPTED

During the fiscal year the inspectors and collaborators of the administration collected from foreign plants and plant products 774 recognized species of insects and 667 insects that could be assigned to family or genus only, 206 recognized species of fungi and bacteria, 29 recognized species of nematodes and numbers of interceptions of fungi, bacteria, and nematodes that could be referred to family or genus only. Many of these interceptions were of considerable economic or scientific importance.

The West Indian fruit fly (*Anastrepha fraterculus*) was intercepted in mango from the Bahamas, Costa Rica, Honduras, and St. Vincent, mango and soursop from Jamaica, and grapefruit, guava, mango, orange, and tropical almond (*Terminalia catappa*) from Porto Rico; the Mexican fruit fly (*A. ludens*) in grapefruit, mamey, mango, orange, pear, quince, and Satsuma orange from Mexico; *A. serpentina* in grapefruit from Trinidad; *Anastrepha* sp. in mango from the Bahamas, Cuba, Dominica, Jamaica, Mexico, and Porto Rico, and guava from Jamaica. Larvae of the melon fly (*Bactrocera cucurbitae*) were found in cucumber and tomato, and pupae among dried onions from Hawaii. The Mediterranean fruit fly (*Ceratitis capitata*) was intercepted in loquat, orange, and pepper (*Capsicum annuum*) from the Azores; in navel orange from Brazil; pupae in a package with the fruit of *Cotoneaster henryi* from France; in avocado, mango, and pepper from Hawaii; in citron, lemon, Mandarin orange, orange, and tangerine from Italy; in loquat, mango, and prickly pear from the Madeira Islands, and in orange from Spain. The olive fly (*Dacus oleae*) was found in olive from Italy. *Rhagoletis* sp. was taken in sour cherry from Italy and Yugoslavia, and Chinese hawthorn (*Crataegus pinnatifida*) fruit and walnut from Mexico. The papaya fruit fly (*Toxotrypana curvicauda*) infested papaya from the Bahamas.

The pink bollworm (*Pectinophora gossypiella*) was intercepted in cottonseed from Brazil, China, Manchuria, Mexico, Porto Rico, and St. Kitts; in seed cotton from Antigua, Mexico, Nevis, and Porto Rico; in cotton bolls from China and Hawaii; in cotton lint from Egypt, Mexico, and Porto Rico; and in cottonseed in cotton used as packing from Cyprus, Egypt, and Syria.

The dagger moth (*Acronycta auricomma*) was intercepted on mahaleb stock from France; the sorrel cutworm (*A. rumicis*) on myrobalan plum stock from France; *Acronycta* sp. (Noctuidae) on cherry,

mahaleb, Manetti, and myrobalan stocks from France; *Emphytus cinctus* (sawfly) in Manetti stock from England, Ireland, and the Netherlands; in *Rosa multiflora* stock from the Netherlands; in rose stock from Germany, and in horticultural varieties of roses from France, Germany, and Luxemburg; European tussock moth (*Notolophus antiqua*) on mahaleb stock from France, and Manetti stock from the Netherlands.

Turnips from England and the Netherlands were infested with the turnip gall weevil (*Ceutorhynchus pleurostigma*), turnips from France with *C. picitarsis* and *C. sulcicollis*, turnips from Denmark with *C. quadridens*, turnips from Denmark, England, France, and Spain with *Psylliodes chrysocephala* (Chrysomelidae), turnips from France with *Baris laticollis* (Curculionidae), and turnips from England with *Taeniothrips firmus* (thrips).

Brachycerus albidentatus (Brachyceridae) arrived in cipollini from Morocco and *Exosoma lusitanica* (Chrysomelidae) infested cipollini from Italy and Morocco. Globe artichokes from France were infested with *Apion carduorum* (Curculionidae). The sweetpotato stem borer (*Omphisa anastomosalis*) was found in sweetpotato from China, and *Palaeopus costicollis* (Curculionidae) infested sweetpotato from Jamaica. *Cylas turcipennis* (Curculionidae) arrived in sweetpotato from the Philippines. The mango weevil (*Sternochetus mangiferae*) infested mango seed from Hawaii. *Conotrachelus aguacatae* (Curculionidae) was intercepted in avocados from Mexico. The sugarcane moth borer of India (*Chilo simplex*) was found in rice straw packing from India and Japan. Orchids from the Philippines were infested with the weevil *Tadus erirhinoides*. A larva of the gipsy moth (*Porthetria dispar*) was collected on an Azalea plant from Japan. The brown-tail moth (*Nygmia phaeorrhoea*) was taken on myrobalan plum stock from France. Lima beans from Cuba and string beans from Cuba, Hawaii, and Porto Rico were infested with the bean pod borer (*Maruca testulalis*). *Dialeurodes chittendeni* (whitefly) was found on rhododendron from England. The citrus blackfly (*Aleurocanthus woglumi*) arrived on various hosts from Cuba and Jamaica.

The lesser bulb fly (*Eumerus strigatus*) was intercepted in narcissus from the Netherlands and onion from Scotland. *E. tuberculatus* was taken in narcissus from the Netherlands. Chestnuts from France, Italy, Japan, Portugal, Spain, Switzerland, and Turkey were infested with *Laspeyresia splendana* (Olethreutidae), and its variety *L. splendana reaumurana* was intercepted in chestnuts from Italy and Portugal.

The following airplane interceptions were made: Citrus blackfly (*Aleurocanthus woglumi*) on Cape-jasmine from Cuba and *Citrus* sp. from Jamaica; *Anastrepha* sp. in mango from the Bahamas; *Coccus viridis* (Coccidae) on Cape-jasmine from Cuba and coffee from Porto Rico; *Coccus* sp. on *Cattleya* sp. (orchid) from Venezuela; *Furcaspis biformis* (Coccidae) on orchid from British Guiana and Panama; geometrid on *Camellia* sp. (flower) from Mexico; coffee leaf miner (*Leucoptera coffeella*) on coffee from Porto Rico; *Odonaspis* sp. (Coccidae) on bamboo used as spreader for orchids from British Guiana; *Paratetranychus* sp. (mite) on *Camellia* sp. (flower) from Mexico; *Phenacoccus* sp. (Coccidae) on *Acalypha* sp. (copperleaf) from Cuba; *Protopulvinaria pyriformis* (Coccidae) on Cape-jasmine from Cuba;

Pseudischchnaspis bowreyi (Coccidae) on orchid from Costa Rica; *Tetranychus* sp. (mite) on Cape-jasmine from Cuba; *Vinsonia stellifera* (Coccidae) on orchid from Panama.

Among the more interesting interceptions of bacterial diseases were citrus canker (*Bacterium citri*) on orange from Japan and on pomelo and tangerine from China; the yellow slime disease (*B. hyacinthi*) on shipments of hyacinth bulbs from the Netherlands; and *B. phaseoli* intercepted 98 times on Lima beans from Cuba, 11 times on Lima beans from Mexico, 4 times on string beans from Mexico, and once on string beans from Spain. Among the fungous diseases were the rusts, *Puccinia ornithogali-thyrsoideis* intercepted on several mail shipments of cut flowers of *Ornithogalum thyrsoideis* from South Africa, *P. buxi* on boxwood from England and Ireland, *Uromyces alyxiae*, a rather rare rust, from Hawaii, on *Alyxia* sp., a favored material for the Hawaiian leis or garlands, and *U. genistae-tinctoriae* on *Genista sagittalis* from the Netherlands. Other fungous diseases intercepted included *Botrytis galanthina* on 12 shipments of *Galanthus* sp. from the Netherlands, *Botrytis* sp. (which was determined as a new species) on rhizomatous iris from England, *Cytospora leucostoma* on nectarine cuttings from New Zealand, *Elsinoe canavaliae* intercepted on Lima beans from Cuba 467 times and from Mexico 26 times, *Gloeosporium aquifolii* on holly from Ireland, *G. euonymicolum* on *Euonymus* spp. from Japan, *Helminthosporium oryzae* on rice-straw packing from Japan, *Heterosporium ornithogali* on *Ornithogalum thyrsoideis* cut flowers from South Africa, and *Mycosphaerella stem-matea* on *Vaccinium vitis-idaea* from Norway.

Numerous interceptions of plant material infested with nematodes were made, a new form was found, and the known host range and distribution of others extended. Among the interceptions of nematodes were *Aphelenchus avenae* on cactus from Germany, carrots from Brazil, Germany, Sweden, and South Africa, *Caryopteris mongolensis* from France, onions from Egypt, Greece and Italy, potatoes from Argentina, Canada, Denmark, Egypt, England, Finland, the Netherlands, Spain, South Africa, and Sweden; *A. fragariae* on strawberry from England and Germany; *A. parietinus* on beets from England, Norway, and Sweden, carrots from Belgium, Brazil, England, France, and Germany, celery from England, dahlia from France, horseradish from Germany, narcissus from Cyprus, onions from Germany, parsnips from England and Sweden, potatoes from Belgium, Canada, Denmark, England, Estonia, Finland, France, Germany, Ireland, Norway, and Sweden, strawberry from England; *Caconema radiculicola* on beet from Mexico, *Campanula* spp. from France, carrot from Mexico, *Caryopteris mongolensis* from France, *Clematis* sp. from France, *Cotyledon* spp. from South Africa, *Crassula cotyledon* from South Africa, *Diervilla* sp. from France, *Dioscorea* sp. from Japan, *Euphorbia* spp. from South Africa, fig from Italy, *Hedera* sp. from France, iris rhizomes from Japan, potatoes from Australia, Chile, Dutch Guiana, France, and Mexico, *Pyrethrum* sp. from France, rose from Canada, France, the Netherlands, and Germany; *Thalictrum delavayi* from France, *Veronica longifolia maritima* from France; *Tylenchus dipsaci* on carrot from England, *Galanthus* sp. from England, hyacinth from the Netherlands, iris from the Netherlands, narcissus from Canada and the Netherlands, onion from England, France, and the Netherlands, potatoes from Belgium, Canada, England,

Finland, France, Germany, the Netherlands, and Italy; *T. tritici* on wheat from Yugoslavia and Syria. An undescribed genus and species heretofore found only in strawberry plants in this country was intercepted in carrots from England and Sweden, potatoes from Canada, England, the Netherlands, Norway, and Sweden, and strawberry plants from Germany. This nematode is a plant parasite superficially resembling *T. dipsaci* in appearance and may be mistaken for it.

A total of 16,534 interceptions of insects and plant diseases were made during the fiscal year 1931. Collaborators stationed in California made 4,503 interceptions of insects and 56 interceptions of plant diseases, and collaborators in Florida made 780 interceptions of insects and 376 interceptions of plant diseases, practically all of which were identified by State authorities. A record of the interceptions of insects and plant diseases made at other ports appears in Table 32.

TABLE 32.—Number of interceptions of insects and plant diseases made during fiscal year 1931, exclusive of California and Florida

Port	Cargo		Stores		Baggage		Quarters		Mail		Total	
	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases
Astoria ¹	0	0	6	9	0	0	1	1	0	0	7	10
Baltimore.....	28	7	38	20	0	1	2	0	6	1	74	29
Bellingham.....	12	6	2	1	0	0	0	0	0	0	14	7
Boston.....	22	10	92	29	91	9	4	0	27	6	236	54
Brownsville.....	9	2	0	0	53	4	0	0	0	0	62	6
Buffalo.....	1	6	0	0	2	1	0	0	0	0	3	7
Calexico.....	0	0	0	0	0	0	0	0	0	0	0	0
Charleston.....	340	1	80	124	12	2	7	4	0	0	439	131
Chicago.....	2	3	0	0	0	0	0	0	11	8	13	11
Cincinnati.....	3	0	0	0	0	0	0	0	0	0	3	0
Columbus, N. Mex.....	0	0	0	0	0	0	0	0	0	0	0	0
Del Rio.....	0	0	0	0	2	0	0	0	0	0	2	0
Detroit.....	81	135	0	0	5	1	0	0	24	52	110	188
Douglas.....	2	1	0	0	9	4	0	0	0	0	11	5
Eagle Pass.....	7	1	0	0	12	1	0	0	0	0	19	2
El Paso.....	4	5	0	0	87	59	0	0	2	1	93	65
Fabens.....	0	0	0	0	9	3	0	0	0	0	9	3
Galveston.....	3	0	1	3	0	0	0	0	0	0	4	3
Gulfport.....	0	0	13	17	0	0	3	0	0	0	16	17
Hawaii.....	228	6	9	1	142	0	121	0	130	1	630	8
Hidalgo.....	0	0	0	0	11	1	0	0	0	0	11	1
Houston.....	3	0	1	0	4	1	0	0	0	0	8	1
Laredo.....	8	7	0	0	32	2	0	0	1	0	41	9
Mobile.....	45	1	20	9	0	0	17	4	0	0	82	14
Naco.....	0	6	0	0	2	3	0	0	0	0	2	9
New Orleans.....	1,025	84	308	161	57	3	100	20	8	1	1,498	269
New York.....	813	740	38	31	103	52	5	3	26	31	985	857
Nogales.....	74	100	0	1	36	9	0	0	2	0	112	110
Norfolk.....	16	5	188	49	17	9	36	18	0	0	257	81
Philadelphia.....	376	291	550	623	108	70	153	103	238	160	1,425	1,247
Port Arthur ²	2	0	10	5	0	0	0	0	0	0	12	5
Portland, Oreg.....	12	14	0	1	0	0	0	0	6	1	18	16
Presidio.....	4	0	0	0	34	10	0	0	0	0	38	10
Rio Grande.....	0	0	0	0	3	3	0	0	0	0	3	3
Roma.....	1	0	0	0	1	0	2	0	0	0	4	0
San Juan.....	3	0	2	3	1	1	0	0	0	0	6	4
San Ysidro.....	1	0	0	0	2	1	0	0	0	0	3	1
Sasabe ³	0	0	0	0	3	1	0	0	0	0	3	1
Savannah.....	0	1	4	15	0	0	2	0	0	0	6	16
Seattle.....	33	12	66	53	42	25	55	35	5	9	201	134
St. Louis.....	0	1	0	0	0	0	0	0	0	0	1	0
Thayer.....	0	0	0	0	10	2	0	0	0	0	10	2

¹ The records cover only the period July 1 to Mar. 16 of the fiscal year 1931.

² Includes interceptions made at Beaumont and Sabine, Tex., and Lake Charles, La.

³ Inspector stationed at Sasabe, Ariz., since Feb. 10, 1931.

TABLE 32.—*Number of interceptions of insects and plant diseases made during fiscal year 1931, exclusive of California and Florida—Continued*

Port	Cargo		Stores		Baggage		Quarters		Mail		Total	
	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases
Washington, D. C., inspection house.....	256	93	0	0	13	3	0	0	422	165	691	261
Wilmington, N. C. ⁴	1	0	25	11	1	0	0	0	0	1	27	12
Ysleta.....	0	0	0	0	0	0	0	0	0	0	0	0
Zapata.....	0	0	0	0	1	0	0	0	0	0	1	0
Miscellaneous.....	31	12	1	0	4	0	0	0	9	7	45	19
Total.....	3, 446	1, 550	1, 454	1, 166	909	281	508	188	917	445	7, 234	3, 630

⁴ Inspector stationed at Wilmington, N. C., since Oct. 1, 1930.

NOTE.—Inspectors stationed in Porto Rico made 217 interceptions of insects and 85 interceptions of plant diseases during their field and packing-house inspection of fruits and vegetables for shipment to the mainland.

INTERCEPTIONS OF PROHIBITED PLANTS AND PLANT PRODUCTS

A record of the number of interceptions of contraband plants and plant products made by inspectors and collaborators of the administration at the various maritime ports appears in Table 33.

TABLE 33.—*Number of interceptions of contraband plants and plant products, fiscal year 1931*

Port	In baggage	In mail	In cargo	In stores	In quarters
Astoria ¹	0	0	0	3	0
Baltimore.....	21	48	1	64	46
Bellingham.....	439	0	0	0	0
Boston.....	254	129	3	4	2
Brunswick, Ga. ²	0	0	0	1	7
Buffalo.....	413	0	0	0	0
Charleston.....	2	0	0	16	85
Chicago.....	0	428	2	0	0
Detroit.....	150	311	26	0	0
Galveston.....	23	0	0	18	19
Gulfport.....	0	0	0	2	4
Houston.....	203	0	8	56	8
Honolulu ³	2, 099	52	160	1	0
Jacksonville ³	2	71	0	30	12
Key West ³	1, 033	0	0	11	8
Los Angeles ³	0	96	0	0	0
Miami ³	1, 317	17	12	105	933
Mobile.....	10	5	2	30	56
Newport News ³	0	0	1	31	1
New Orleans.....	531	10	4	165	720
New York ⁴	3, 402	803	35	11	142
Norfolk.....	9	0	1	307	39
Pensacola ³	0	0	0	21	2
Philadelphia.....	107	510	24	259	210
Portland, Oreg.....	1	11	0	0	0
Porto Rico (all ports).....	238	0	0	31	29
Providence.....	271	0	0	0	0
San Diego ³	32	1	1	55	40
San Francisco ³	301	45	34	391	180
San Pedro ³	99	0	1	181	65
Savannah.....	0	0	0	18	91
Seattle.....	279	62	0	8	0
Tampa ³	11	0	0	36	65
Wilmington, N. C. ⁵	2	0	0	0	0
Total.....	11, 249	2, 599	315	1, 855	2, 764

¹ The records cover only the period July 1 to Mar. 16, fiscal year 1931.

² Work handled by inspector stationed at Savannah, Ga.

³ Collaborators are stationed at these ports.

⁴ In addition 836 interceptions were made in appraisers' stores and 145 in Porto Rican express.

⁵ Inspector stationed at Wilmington Oct. 1, 1930.

RECORDS OF IMPORTS OF RESTRICTED PLANTS AND PLANT PRODUCTS

Under various foreign quarantines certain plants and plant products are restricted as to entry, are subject to inspection and, if necessary, disinfection, for the purpose of excluding plant diseases and insect pests. Among such restricted plants and plant products are nursery stock, plants, bulbs, and seeds; fruits and vegetables; grains from certain countries, brooms, and broomcorn; cotton waste, cotton wrappings (bagging), and cottonseed products; also cottonseed, seed cotton, and cottonseed hulls from the Imperial Valley, Lower California, Mexico. A record of the importation of these products, inspected by inspectors of the administration and, if necessary, treated under their supervision, is given.

IMPORTATIONS OF NURSERY STOCK, PLANTS, BULBS, AND SEEDS

The importations recorded in Tables 34 to 38, inclusive, are entered under regulation 3 of quarantine No. 37, under permits that are valid until revoked and that do not limit the quantity that may be imported. The restrictions under this regulation are intended merely to afford opportunity to inspect and, if necessary, to safeguard the products as they are entered. Table 34 records the number of importations of fruit, rose, and nut stocks, cuttings, and scions inspected and, if necessary, safeguarded during the fiscal year 1931. For comparison, there is also indicated in this table the total number of such importations similarly handled during the fiscal year 1930. A record of certain bulbs entered under permit subject to inspection and treatment is furnished in Table 35. Table 36 is a record of the number of various kinds of bulbs entered under permit for the preceding eight years. Table 37 shows the number of pounds of tree seeds imported under permit for the fiscal year 1931, and the countries of origin of such seeds, and Table 38 indicates the distribution by States of the bulbs, nursery stock, and seeds shown in Tables 34 to 37, inclusive.

TABLE 34.—*Importation of fruit, rose, and nut stocks, cuttings, and scions under regulation 3, quarantine No. 37, fiscal year 1931*

[Figures indicate number of plants]

Kind of stocks, cuttings, and scions	Bel- gium	Can- ada	Canal Zone	China	Czecho- slovakia	England	France	Ger- many	Hun- gary	Ireland	Italy	Nether- lands	Poland	Scotland	Syria	Yugo- slavia	Total	
																	1931	1930
Apple ¹	---	177	---	---	49	175	10	20	---	---	23	---	54	---	---	---	508	2, 506, 528
Apricot.....	---	---	36	---	---	---	---	---	---	---	---	---	---	---	---	---	36	71
Avocado.....	---	---	---	---	20	---	4, 193, 500	---	---	---	---	---	---	---	---	---	4, 193, 520	3, 926
Cherry ¹	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6, 663, 750	200
Cranberry.....	---	---	---	---	---	36	---	---	---	---	498	---	---	---	---	---	541	217
Fig.....	---	---	---	---	---	---	---	---	---	---	104	---	---	---	---	---	825	1, 307
Grape.....	75	---	---	20	---	---	330	12	111	---	4	---	---	---	---	33	4	---
Mulberry.....	---	---	---	---	---	---	---	---	---	---	---	---	26	---	---	2	13, 560	17, 212
Nut.....	---	32	---	---	---	20	13, 500	---	---	---	---	---	---	---	---	---	24	---
Olive.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	13	---
Pear ¹	---	13	---	---	---	---	---	---	---	---	18	---	---	---	---	---	18	1, 536, 916
Pineapple.....	---	---	399	---	---	---	---	---	---	---	---	---	---	---	---	---	399	---
Plum.....	---	---	---	---	---	222	567, 000	---	---	---	60	---	---	---	---	---	567, 252	825, 856
Prune.....	---	---	---	---	---	---	---	---	---	---	7	---	---	---	---	---	7	---
Quince ¹	---	---	---	---	---	2, 022, 650	1, 250, 950	98, 758	---	50, 500	---	---	---	25, 000	---	---	13, 172, 482	260, 650
Rose.....	---	5, 000	---	---	---	6	70	165	---	---	---	---	---	---	---	---	241	11, 206, 730
Miscellaneous fruits.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	21
Total.....	75	5, 222	435	20	69	2, 023, 109	6, 025, 360	98, 955	111	50, 500	714	9, 719, 624	80	25, 000	151	35	17, 949, 460	23, 023, 384

¹ The importation of apple, pear, quince, and mazzard cherry stocks after June 30, 1930, was prohibited. The cherry stocks reported are mahaleb cherry. The apples and pears are cuttings.

TABLE 35.—*Importation of bulbs under regulation 3, quarantine No. 37, fiscal year 1931*

[Figures indicate number of bulbs]

Bulbs	Argentina	Australia	Azores	Bermuda	Canada	China	England	France	Germany	India	Ireland	Italy
Chionodoxa							512		17,104,875			
Convallaria							12					
Crocus							4,895					
Eranthis							1,156		10		368	
Fritillaria							54					
Galanthus							7,630	393,160				
Hyacinth	5						80					
Ixia							12,369	1,307,742	12,502	648		4,000
Lily			1,650	933,838	545	3,555	1,013					
Muscari							5,066					
Sella							2,318	133,500	1,069			7,006
Tulip					500							
Total	5	5	1,650	933,838	1,045	3,555	35,105	1,834,402	17,118,456	648	368	11,006

Bulbs	Japan	Manchuria	Netherlands	Palestine	Philippine Islands	Portugal	Russia	Scotland	Switzerland	Sweden	Turkey	Total
Chionodoxa			547,953									548,465
Convallaria			168,177									17,273,064
Crocus			9,027,923	10							150	9,033,346
Eranthis			185,360									186,516
Fritillaria			166,104									166,174
Galanthus			896,572									918,613
Hyacinth			21,365,980							11	14,400	21,759,225
Ixia			368,982									368,982
Lily	16,660,611	10,000	613,906		514	20		6				19,561,911
Muscari			1,522,230									1,523,243
Sella			1,693,987								70	1,699,123
Tulip			153,722,536				31	300		33	770	153,868,063
Total	16,660,611	10,000	190,279,710	10	514	20	31	306	6	44	15,390	226,906,725

TABLE 36.—Summary of bulb importations under regulation 3, quarantine No. 37, for fiscal years 1924-1931

[Figures indicate number of bulbs]

Bulbs	1924	1925	1926	1927	1928	1929	1930	1931
Chionodoxa.....	339,766	465,422	839,637	466,872	439,075	487,228	476,422	548,465
Convallaria.....	17,568,835	18,980,311	20,543,785	20,558,460	24,738,880	23,087,167	23,661,236	17,273,064
Crocus.....	10,815,920	10,624,870	10,898,968	9,969,070	8,775,467	9,886,546	8,075,439	9,033,346
Erantulus.....	93,314	152,787	214,173	144,150	133,842	143,592	188,611	186,516
Fritillaria.....	92,951	104,483	209,543	125,688	111,778	115,658	122,690	166,174
Galanthus.....	797,351	895,003	1,128,335	844,944	662,989	718,130	751,523	918,613
Hyacinth.....	32,197,740	27,947,261	23,682,500	23,711,178	22,127,888	21,450,547	20,253,057	21,739,225
Ixia.....	335,158	371,983	545,278	529,404	704,044	827,154	461,252	368,982
Lily.....	9,680,486	11,207,559	16,031,090	16,228,762	19,917,477	21,453,024	20,737,428	19,561,911
Muscari.....	612,329	906,259	1,404,573	993,339	1,150,220	1,639,982	1,473,455	1,523,243
Narcissus.....	92,659,666	106,314,049	142,384,199	(¹)	(¹)	(¹)	(¹)	(¹)
Scilla.....	994,762	1,742,514	2,012,750	1,553,313	1,341,085	1,436,988	1,544,889	1,699,123
Tulip.....	92,539,157	96,290,452	106,849,572	129,681,036	161,940,818	191,959,162	163,604,912	153,808,063
Unclassified.....				11,112				
Total.....	258,737,465	276,002,753	326,744,463	204,816,928	242,046,763	273,205,178	241,352,923	226,906,725

¹ Imported under regulation 14, quarantine No. 37, since Jan. 1, 1926.

TABLE 37.—*Importation of tree seeds under regulation 3, quarantine No. 37, fiscal year 1931*

[Figures indicate number of pounds]

Country of origin	Apple	Apri- cot	Avo- cado	Cherry	Citrus	Elm	Grape	Nut and palm	Onion sets	Orna- mental and tree	Peach	Pear	Persim- mon	Plum	Quince	Rose	Miscel- laneous	Total
Africa.....								1		10	8							19
Australia.....								25,875		117								26,032
Austria.....	345							2		10,159		156		50		2	40	12,781
Bahamas.....			2,067					5										5
Brazil.....								709		90								799
British Honduras.....								1		2								3
Bulgaria.....														1,102				1,102
Canada.....										368	54							422
Canal Zone.....																	2	2
Canary Islands.....										10								10
Ceylon.....								10		7								7
Chile.....							375	547		2,485		17	2					11
China.....																	1	3,427
Colombia.....								3		9							1	1
Cuba.....			520							864								532
Czechoslovakia.....										971								864
Denmark.....																5		976
England.....									3	2								5
Finland.....										213								213
France.....	7,788			6,915		120		17		1,393		985			52			17,170
Germany.....				49				44		2,764						27		2,884
Guan.....								3		98								101
Hungary.....									6									6
India.....								2		27							5	34
Ireland.....																		13
Italy.....						136		18		1,621								1,675
Jamaica.....								10										10
Japan.....		5				41	1	387		9,974		924	57			853		12,242
Java.....								10		2								12
Manchuria.....										297								25
Mauritius Island.....		1						25										350
Mexico.....					292					61							4	357
Netherlands.....										30								30
New Zealand.....										4								4
Philippine Islands.....																		14
Poland.....								2		12								103
Russia.....										103								103
										24								24

¹ The importation of elm seeds (*Ulmus* spp.) from Europe was prohibited on and after Dec. 22, 1930, the effective date of the revised regulations supplemental to quarantine No 37. Those reported from European countries arrived prior to that date.

TABLE 37.—*Importation of tree seeds under regulation 3, quarantine No. 37, fiscal year 1931—Continued*

Country of origin	Apple	Apri- cot	Avo- cado	Cherry	Citrus	Elm	Grape	Nut and palm	Onion sets	Orna- mental and tree	Peach	Pear	Persim- mon	Plum	Quince	Rose	Miscel- laneous	Total
Scotland.....									6	223								229
Siam.....										6								6
Spain.....										13								13
Sweden.....										56								56
Switzerland.....								15										15
Trinidad.....								34		88								122
Venezuela.....										10								10
Yugoslavia.....										14								14
Total.....	8,133	6	520	9,031	292	472	1	27,720	15	32,141	62	2,082	59	1,152	52	929	63	82,730

NOTE.—In addition, 196 small packages of miscellaneous seeds were imported from various countries.

TABLE 38.—*Distribution by States of bulbs, nursery stock, and seeds imported under regulation 3, quarantine No. 37, fiscal year 1931*

State	Bulbs	Stocks, ¹ cuttings, and scions				Seeds ²							
		Fruit	Nut	Rose	Total	Elm ³	Fruit	Nut and palm	Ornamental and tree	Rose	Miscellaneous	Onion sets	Total
		Number	Number	Number		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds		
Alabama	Cases 394						65		195				260
Arizona	21												
Arkansas	152												
California	5,998	2,960		716,508	719,468	1	602	18,520	790		61		19,974
Colorado	754			56,500	56,500	110	889	4	15				1,018
Connecticut	2,319	165,000		939,175	1,104,175		190		908	24			1,122
Delaware	460								2				2
District of Columbia	818	20	32		52		17		23				40
Florida	117	399			399				143		1		211
Georgia	1,057					150	58	154	3,259	91			3,712
Idaho	62												
Illinois	18,796	25,000		1,844,700	1,869,700		100	31	2,221	151			2,503
Indiana	1,671	344,000		1,483,400	1,827,400				484				484
Iowa	1,009	1,335,000		192,600	1,527,600	25	1,054	3	706	35			1,823
Kansas	455	258,000			258,000		4,547		2,009				6,556
Kentucky	560			10,000	10,000				12				12
Louisiana	208						6		20				26
Maine	398								19				19
Maryland	1,238	171		102,500	102,671		29	4	56				89
Massachusetts	5,503			100,000	100,000		11	4	436				452
Michigan	4,734	60,000	26	230,100	290,126				195	7			202
Minnesota	1,740					10			331				341
Mississippi	125	64			64								
Missouri	2,221	379,009		127,000	506,009		1,685	24	6	1			1,716
Montana	135												
Nebraska	433			500	500				72				72
Nevada	3												
New Hampshire	210			5,000	5,000				491				491
New Jersey	8,329			1,186,575	1,186,575		103	300	1,208	186			1,797
New Mexico	28												
New York	61,361	1,755,254	8,500	3,928,750	5,692,504		1,847	4,683	1,595	67		15	8,207
North Carolina	267								1,429				1,429
North Dakota	67			500	500				2				2

¹ The importation of apple, pear, quince, and mazard cherry stocks after June 30, 1930, was prohibited. The cherry stocks reported are mahaleb cherry. The apples and pears are cuttings.

² In addition, 196 small packages of miscellaneous seeds were imported from various countries.

³ The importation of elm seeds (*Ulmus* spp.) from Europe was prohibited on and after Dec. 22, 1930, the effective date of the revised regulations supplemental to quarantine No. 37. Those reported from European countries arrived prior to that date.

TABLE 38.—*Distribution by States of bulbs, nursery stock, and seeds imported under regulation 3, quarantine No. 37, fiscal year 1931—Contd.*

State	Bulbs	Stocks, cuttings, and scions				Seeds						
		Fruit	Nut	Rose	Total	Elm	Fruit	Nut and palm	Ornamental and tree	Rose	Miscellaneous	Onion sets
		Number	Number	Number		Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Total
Ohio.....	Cases 6, 904	176, 138	5, 000	1, 847, 749	2, 028, 887	---	3	68	660	---	1	732
Oklahoma.....	296	---	---	---	---	---	---	---	43	---	---	43
Oregon.....	560	---	---	---	---	---	5, 671	---	134	---	---	5, 805
Pennsylvania.....	20, 995	10, 079	---	176, 050	186, 131	---	3, 048	3, 186	7, 938	120	---	14, 362
Rhode Island.....	1, 505	---	2	37, 075	37, 075	70	---	---	105	---	---	105
South Carolina.....	708	---	---	---	---	---	---	---	10	---	---	10
South Dakota.....	32	---	---	1, 000	1, 000	---	---	---	2	---	---	2
Tennessee.....	680	150, 000	---	40, 000	190, 000	10	---	---	3	---	---	13
Texas.....	708	10, 000	---	5, 000	15, 000	16	297	9	194	---	---	516
Utah.....	237	72, 000	---	5, 000	77, 000	---	---	---	---	---	---	---
Vermont.....	282	30	---	---	30	---	---	---	---	---	---	---
Virginia.....	954	20, 075	---	---	20, 075	---	---	640	54	---	---	694
Washington.....	2, 649	---	---	---	---	4	195	9	238	1	---	447
West Virginia.....	454	20	---	---	20	---	---	---	5	---	---	5
Wisconsin.....	2, 456	199	---	96, 800	96, 999	---	---	---	200	---	---	200
Wyoming.....	5	---	---	---	---	---	973	---	2	---	---	2
Various States.....	---	---	---	---	---	76	---	1	5, 729	245	---	7, 024
Exported by permittees.....	2, 171	---	---	40, 000	40, 000	---	---	13	197	---	---	210
Total.....	163, 719	4, 763, 418	13, 560	13, 172, 482	17, 949, 460	472	21, 390	27, 720	32, 141	929	63	82, 730

The record of entry under special permits issued under the provisions of regulation 14 of quarantine No. 37 for the purpose of keeping the country supplied with new, improved, or unavailable varieties and necessary propagating stock and for experimental, educational, or scientific purposes is given in Table 39.

TABLE 39.—*Special-permit importations, fiscal year 1931, with combined total for fiscal years 1920-1931*

Class of plants	Fiscal year 1931 ¹				Total for fiscal years, 1920-1931 ¹			
	Permits issued		Importations under permits		Permits issued		Importations under permits	
	Num-ber	Quantity authorized	Num-ber	Quantity imported	Num-ber	Quantity authorized	Num-ber	Quantity imported
Dahlia.....	67	2, 429	59	2, 115	720	54, 236	613	38, 599
Gladiolus.....	142	44, 779	123	33, 755	1, 770	50, 579, 414	1, 481	28, 568, 062
Iris, bulbous.....	114	2, 731, 190	133	2, 957, 729	1, 429	50, 444, 374	1, 201	35, 757, 375
Iris, rhizomatous.....	104	19, 217	88	4, 736	1, 424	288, 187	1, 241	144, 435
Narcissus.....	148	5, 203, 930	175	6, 973, 136	1, 203	159, 003, 052	983	76, 504, 511
Orchid.....	235	14, 319	212	11, 567	1, 663	212, 203	1, 483	161, 914
Peony.....	50	6, 077	47	5, 491	1, 197	1, 394, 416	976	679, 780
Rose.....	125	14, 248	125	12, 831	1, 269	247, 086	1, 095	179, 078
Fruit (trees and small fruits).....	14	2, 290	7	637	160	17, 960	108	8, 042
Herbaceous.....	155	22, 736	133	20, 046	1, 444	4, 782, 041	1, 163	2, 973, 410
Miscellaneous bulbs, roots, etc.....	155	108, 970	129	66, 184	1, 570	12, 839, 960	1, 359	6, 688, 515
Ornamental.....	321	60, 866	255	33, 230	1, 991	3, 872, 843	1, 579	2, 204, 993
Total.....		8, 231, 051		10, 121, 457		283, 735, 772		153, 908, 714

¹ Includes importations into Hawaii for fiscal year 1931. Importations into Hawaii not included in totals for previous years.

NOTE.—The disparity in the number of bulbs, plants, etc., imported, as compared with the number authorized entry, may be explained by the fact that permits for some classes of plants, particularly narcissus and bulbous iris, are usually issued during one fiscal year and the importations made during the following fiscal year.

During the year 1,425 special permits were issued authorizing entry to 8,231,051 plants, bulbs, etc. A total of 10,121,457 plants, bulbs, etc., were imported under 1,302 permits as compared with 2,071,399 plants, bulbs, etc. imported in 1930. Importations of narcissus were 6,488,958 bulbs in excess of those for 1930, and importations of bulbous iris were increased by 1,699,914 bulbs. The total importations of gladiolus, rhizomatous iris, orchids, roses, and fruits (trees and small fruits) were 13,222 plants, etc., in excess of the 1930 importations of these classes of plants. Importations of dahlias, peonies, herbaceous plants, miscellaneous bulbs, roots, etc., and ornamentals were 152,036 plants, etc., less than for these classes of plants in 1930; the greatest decrease being from 167,666 to 66,184 for miscellaneous bulbs, roots, etc. A summary of special permits issued during the entire period of the quarantine to date is given in Table 40.

TABLE 40.—*Special-permit importations, yearly totals for fiscal years 1920-1931*

Fiscal year	Permits issued		Importations under permits	
	Number	Quantity authorized	Number	Quantity imported
1920.....	311	10,752,844	171	3,484,195
1921.....	622	13,965,013	411	8,132,634
1922.....	750	9,573,199	518	3,344,026
1923.....	897	15,175,003	719	10,357,406
1924.....	1,107	15,381,621	862	12,561,306
1925.....	1,235	9,517,913	1,087	8,575,129
1926.....	1,445	80,982,954	1,200	6,021,508
1927.....	1,453	54,006,343	1,256	46,624,587
1928.....	1,602	37,953,209	1,357	24,643,420
1929.....	1,353	16,979,528	1,348	17,971,647
1930.....	1,800	11,217,094	1,064	2,071,399
1931 ¹	1,425	8,231,051	1,302	10,121,457
Total ¹	13,500	283,735,772	11,295	153,908,714

¹ Includes importations into Hawaii for fiscal year 1931. Importations into Hawaii not included in totals for previous years.

NOTE.—The disparity in the number of bulbs, plants, etc., imported, as compared with the number authorized entry, may be explained by the fact that permits for some classes of plants, particularly narcissus and bulbous iris, are usually issued during one fiscal year and the importations made during the following fiscal year.

The number of varieties considered has now reached a total of 55,105 (an increase of 4,034 during the year), of which 52,947 have been approved for entry. Table 41 shows the distribution of these varieties among the various classes of plants as well as a comparison of the 1931 importations with those of 1930 for each class. The distribution of the imported special-permit material by States is shown in Table 42.

TABLE 41.—*Special-permit material: Number of different varieties of plants requested and approved for fiscal years 1920-1931, and comparison of importations for fiscal years 1930 and 1931*

Class of plants	Varieties of plants for which permits were requested and approved, 1920-1931			Comparison showing number of plants, bulbs, etc., imported	
	Number of varieties for which permits were requested	Number of varieties for which permits were approved	Percentage approved	1930	¹ 1931
Dahlia.....	3,511	3,365	95.84	2,898	2,115
Gladiolus.....	2,035	1,901	93.42	25,464	33,755
Iris, bulbous.....	533	532	99.81	1,257,815	2,957,729
Iris, rhizomatous.....	2,999	2,852	95.10	4,418	4,736
Narcissus.....	1,998	1,988	99.50	484,178	6,973,136
Orchid.....	11,016	10,993	99.79	9,634	11,567
Peony.....	2,270	2,019	88.94	14,780	5,491
Rose.....	4,906	4,471	91.13	10,394	12,831
Fruit (trees and small fruits).....	338	323	95.56	394	637
Herbaceous.....	6,857	6,669	97.26	25,395	20,046
Miscellaneous bulbs, roots, etc.....	3,415	3,375	98.83	167,666	66,184
Ornamental.....	15,227	14,459	94.96	68,363	33,230
Total.....	55,105	52,947	96.08	2,071,399	10,121,457

¹ Includes importations into Hawaii for fiscal year 1931. Importations into Hawaii not included in totals for previous years.

TABLE 42.—*Distribution of special-permit material by States for fiscal years 1920-1931*

State or Territory	Dahlia	Gladiolus	Iris, bulbous	Iris, rhizom- atous	Narcissus	Orchid	Peony
Alabama.....		15, 115	30, 980		6, 000		
Arizona.....	14	12			1, 000	14	
Arkansas.....			18, 000				
California.....	6, 482	1, 926, 857	10, 854, 235	30, 588	5, 679, 863	37, 395	3, 282
Colorado.....	66	31, 803	33, 490			2, 055	150
Connecticut.....	1, 073	16, 312	62, 745	1, 543	57, 185	717	113
Delaware.....		2, 000	169, 300	22	28	1, 773	1, 018
District of Columbia.....	166	516	215	93	178	331	
Florida.....		48, 930	357, 362		6, 915, 130	346	
Georgia.....	360	9, 210	296, 485	181	11, 696		
Hawaii ²				527		1, 679	
Idaho.....		926	2, 534	24			
Illinois.....	138	3, 258, 961	901, 390	15, 528	306, 410	1, 470	47, 405
Indiana.....	186	2, 389, 928	502, 756	3, 043	1, 317	360	9, 201
Iowa.....		112, 225	10, 035	8	250		24, 012
Kansas.....	99		32	2, 263	141		3, 059
Kentucky.....	408		51, 200		533	415	133
Louisiana.....	129	2, 695	21, 750		10, 363	1, 697	
Maine.....		350		43			262
Maryland.....	545	23, 065	559, 396	413	1, 683, 175	560	20, 815
Massachusetts.....	1, 877	3, 444, 626	521, 551	3, 435	102, 539	27, 487	6, 761
Michigan.....	4, 453	12, 379, 496	1, 147, 962	3, 419	2, 614, 929	693	87, 561
Minnesota.....	92	88, 276	345	3, 375	11, 000	722	7, 549
Mississippi.....	49	6, 500	52, 776	9	9, 260		
Missouri.....	253	3, 173	281, 211	641	1, 238	4, 466	991
Montana.....		32					
Nebraska.....	276	1, 142					14
New Hampshire.....	7	40, 057	21, 730	57	123	67	
New Jersey.....	7, 693	118, 426	1, 108, 169	11, 115	649, 229	25, 634	40, 975
New Mexico.....			5, 000		84		
New York.....	4, 751	2, 645, 823	5, 817, 033	36, 505	14, 702, 673	34, 468	222, 007
North Carolina.....	82	775, 361	4, 553, 695		1, 377, 305	845	
North Dakota.....		27, 043					7
Ohio.....	2, 336	485, 872	46, 884	20, 687	1, 289	491	129, 343
Oklahoma.....		510	14, 000				
Oregon.....	1, 682	73, 646	1, 326, 196	1, 610	2, 719, 767		2, 829
Pennsylvania.....	1, 856	393, 517	311, 993	2, 972	3, 442, 924	16, 336	52, 846
Porto Rico.....						61	
Rhode Island.....	1, 078	1, 007	257, 965	1, 557	316, 800	157	5, 209
South Carolina.....			252, 500		8, 889, 490		
South Dakota.....		1, 701		11			2, 432
Tennessee.....	623		193, 896	598	834, 638		232
Texas.....	1	2, 000	795, 671	50	7, 741, 063	6	
Utah.....		126	30, 750		11, 400		
Vermont.....		15, 713	8, 010	36			2, 359
Virginia.....	313	20, 465	2, 676, 204	4	5, 526, 546	45	1, 682
Washington.....	1, 245	148, 562	2, 349, 963	3, 535	12, 609, 695	610	3, 615
West Virginia.....		230	4, 000				
Wisconsin.....	266	55, 853	107, 966	543	269, 250	1, 014	3, 918
Total ²	38, 599	28, 568, 062	35, 757, 375	144, 435	76, 504, 511	161, 914	679, 780

State or Territory	Rose	Fruit ¹	Herba- ceous ¹	Miscellane- ous bulbs, roots, etc. ¹	Orna- mental	Total
Alabama.....	174		115	35	391	52, 810
Arizona.....	9		231		4, 939	6, 219
Arkansas.....	50					18, 050
California.....	41, 370	252	2, 808	106, 060	2, 088, 673	20, 777, 865
Colorado.....			100		5, 787	73, 451
Connecticut.....	31, 608		2, 354	490	154, 657	328, 797
Delaware.....			42	38	5, 310	179, 531
District of Columbia.....	320			12	318	2, 149
Florida.....	21		50	85, 497	278, 244	7, 685, 580
Georgia.....		2		80	3, 189	321, 203
Hawaii ²		107		318	321	2, 952
Idaho.....			6	180	3	3, 673
Illinois.....	10, 146	7	1, 966	6, 102	228, 328	4, 777, 851
Indiana.....	2, 681		359	7, 809	30, 163	2, 947, 803
Iowa.....		875		180	14, 373	161, 958
Kansas.....	60			133	574	6, 361

¹ Prior to 1929 this material was recorded under ornamentals, etc.² Includes importations into Hawaii for fiscal year 1931. Importations into Hawaii not included in totals for previous years.

TABLE 42.—*Distribution of special-permit material by States for fiscal years 1920-1931—Continued*

State or Territory	Rose	Fruit	Herba- ceous	Miscellane- ous bulbs, roots, etc.	Orna- mental	Total
Kentucky.....			92		8	52, 789
Louisiana.....	190		6	470	464	37, 764
Maine.....			110	761	983	2, 509
Maryland.....	2, 859	6		80	78, 602	2, 369, 516
Massachusetts.....	3, 285		1, 345	3, 027	437, 226	4, 553, 159
Michigan.....	335		13, 642	17, 017	573, 969	16, 843, 476
Minnesota.....	160			1, 011	35, 621	148, 151
Mississippi.....				5	252	68, 851
Missouri.....			255	45	19, 776	312, 049
Montana.....					100	132
Nebraska.....					351	1, 783
New Hampshire.....		1	96	448	1, 395	63, 981
New Jersey.....	38, 531	1	21, 461	17, 015	2, 699, 985	4, 738, 234
New Mexico.....						5, 084
New York.....	24, 636	66	41, 780	250, 822	3, 032, 816	26, 813, 380
North Carolina.....				20, 500	764	6, 728, 552
North Dakota.....	1					27, 051
Ohio.....	5, 205	64	5, 976	3, 984	768, 289	1, 470, 420
Oklahoma.....					198	14, 708
Oregon.....	1, 891		400	61, 697	55, 081	4, 244, 799
Pennsylvania.....	10, 047		177	10, 933	255, 200	4, 498, 801
Porto Rico.....					13	74
Rhode Island.....	552		110		46, 369	630, 804
South Carolina.....					3	9, 141, 993
South Dakota.....	3, 173		12		867	8, 196
Tennessee.....	87				3, 442	1, 033, 516
Texas.....	375		8		76, 140	8, 615, 314
Utah.....					4, 747	47, 028
Vermont.....					2, 506	28, 624
Virginia.....	16		11	2, 136	44, 942	8, 272, 364
Washington.....	776		449	13, 648	161, 492	15, 293, 590
West Virginia.....					36	4, 266
Wisconsin.....	520		1, 126	1, 091	49, 961	491, 508
Total ²	179, 078	1, 381	95, 087	611, 624	11, 166, 868	153, 908, 714

² Includes importations into Hawaii for fiscal year 1931. Importations into Hawaii not included in totals for previous years.

In addition to the foregoing, there was imported from Canada under regulation 15, quarantine No. 37, a total of 477,752 bulbs, plants, trees, and cuttings, as compared with 548,527 during the fiscal year 1930.

To authorize the importation of this material 498 permits were issued in 1931, as compared with 546 in 1930.

IMPORTATIONS OF COTTON, COTTON WRAPPINGS (BAGGING), SEED COTTON, AND COTTONSEED PRODUCTS

Tables 43 to 46, inclusive, indicate, respectively, the importations during the fiscal year of cotton, cotton waste, cotton wrappings (bagging), seed cotton, and cottonseed products which were inspected and, when necessary, fumigated or otherwise treated under supervision. The actual number of bales of cotton, cotton waste, and bagging is indicated, and in as much as bales vary in size they are referred to as "running" bales.

TABLE 43.—*Importation of running bales of ginned cotton, by country of growth and port of entry, fiscal year 1931*

Country	Boston	Buf- falo	Calex- ico	De- troit	El Paso	Fabens	Hous- ton	Island Pond	Ma- lone	New- port	New York	Niaga- ra Falls
Anglo-Egyptian Sudan	121											
British West Indies	5										268	
China	1,953										2,785	
Dutch East Indies											296	
Egypt	11,381										3,386	
Haiti											2	
India	17,864										18,889	
Mexico			25,985		434	234					950	
Nigeria	84											
Peru											1,177	
Porto Rico											1,981	
Russia											2	
United States (re- turned)												
Unknown	337	265		17			51	211	4	619	2,063	1,325
											5	
Total	31,745	265	25,985	17	434	234	51	211	4	619	31,804	1,325

Country	Nor- folk	Ny- ando	Port Hu- ron	Port- land	Rouses Point	Saint Al- bans	San Fran- cisco	San Pe- dro	Seat- tle	Vance- boro	Total
Anglo-Egyptian Sudan											121
British West Indies											273
China							19,497	2,673	2,793		29,701
Dutch East Indies							1,202				1,498
Egypt											14,767
Haiti											2
India				50			1,676	2,880	275		41,634
Mexico							100	700			28,403
Nigeria											84
Peru											1,177
Porto Rico											1,981
Russia											2
United States (returned)	2	38	40		49	661				304	5,986
Unknown											5
Total	2	38	40	50	49	661	22,475	6,253	3,068	304	125,634

¹ Includes 8,306 bales of linters.

TABLE 44.—*Importation of running bales of cotton waste, by country of origin and port of entry, fiscal year 1931*

Country	Balti- more	Boston	Buffalo	Charles- ton	Detroit	Galves- ton	Hous- ton	Jackson- ville	New Or- leans	New- port
Austria										
Belgium		104		37		57				
Canada		401	33		24					525
Ceylon										
China	75									
Egypt										
England		1,501		135			59	92	100	
France		166								
Germany		212				89	140			
Holland		143		33		50	44			
India		75					100			
Ireland										
Italy		182				48			47	
Japan	25	476								
Mexico									152	
Sweden										
Switzerland										
Total	100	3,260	33	205	24	244	343	92	299	525

TABLE 44.—*Importation of running bales of cotton waste, by country of origin and port of entry, fiscal year 1931—Continued*

Country	New York	Niagara Falls	Philadelphia	Port Huron	Saint Albans	San Francisco	San Pedro	Savannah	Seattle	Total
Austria.....	655		22							677
Belgium.....	1,032		96							1,375
Canada.....		50	7	17	429			49		1,486
Ceylon.....			1							1
China.....	625		269			585	158		410	2,122
Egypt.....	177									177
England.....	379		153					107		2,526
France.....	1,372		250							1,788
Germany.....	4,084		1,023							5,548
Holland.....	1,231		556							2,057
India.....	7,205		1,438			525				9,343
Ireland.....	47									47
Italy.....	926		122			54				1,379
Japan.....	771		1,665			2,893	100		2,841	8,771
Mexico.....										152
Sweden.....			27							27
Switzerland.....			48							48
Total.....	18,504	50	5,677	17	429	4,057	258	156	3,251	37,524

TABLE 45.—*Importation of running bales of bagging, fiscal year 1931*

Country	Baltimore	Boston	Buffalo	Charleston	Chicago	Detroit	Galveston	Houston	Lake Charles	New Orleans	New York	Niagara Falls
Argentina.....											360	
Australia.....											9	
Austria.....		83								632		
Belgium.....	623	1,584		313			59	785		1,449	4,877	
British Honduras.....										1		
Canada.....	60	487	236		102	4,167		54			3,257	314
China.....												
Cuba.....	27									360		
Czechoslovakia.....							45	90				
Egypt.....											151	
England.....	486	674		303			920	2,986		3,537	936	
France.....	89	1,085		105			1,255	5,697	75	2,024	3,065	
Germany.....	721	532					1,606	3,803		2,918	3,416	
Greece.....											86	
Holland.....	412	2,668		1,465			934	1,037		8,129	2,502	
Italy.....							262	1,454		1,726	10,198	
Japan.....		197										
Morocco.....											80	
Norway.....										1,884		
Philippine Islands.....											1	
Porto Rico.....											543	
Portugal.....											131	
Russia.....	464										1,089	
Scotland.....										94	2,695	
Spain.....				322						233	3,161	
Switzerland.....										86	121	
United States (returned).....	20											
Total.....	2,902	7,310	236	2,508	102	4,167	5,081	16,086	75	23,073	36,678	314

TABLE 45.—*Importation of running bales of bagging, fiscal year 1931—Contd.*

Country	Norfolk	Philadelphia	Port Huron	Rouses Point	Saint Albans	San Francisco	San Pedro	Sault Ste. Marie	Savannah	Seattle	Total
Argentina.....		170									530
Australia.....											9
Austria.....	479	319									1,693
Belgium.....	647	47				62			2,511		12,957
British Honduras..											1
Canada.....	374	5,309	2,743	1,235	103			253			18,694
China.....						1,843	1,084			205	3,132
Cuba.....											387
Czechoslovakia....									136		271
Egypt.....		74									225
England.....	7,162	3,258							4,481		24,743
France.....	1,227	1,396				107			458		16,583
Germany.....	6,855	563							1,600		22,014
Greece.....											86
Holland.....	9,543	2,214							528		29,432
Italy.....											13,640
Japan.....						2,657	200		78	5,227	8,359
Morocco.....											80
Norway.....											1,884
Philippine Islands.											1
Porto Rico.....	862										1,405
Portugal.....											131
Russia.....	1,614	614									3,781
Scotland.....	68	75									2,932
Spain.....		68									3,784
Switzerland.....	100										307
United States (returned).....											20
Total.....	28,931	14,107	2,743	1,235	103	4,669	1,284	253	9,792	5,432	167,081

TABLE 46.—*Importation, in pounds, of seed cotton, cottonseed hulls, and cottonseed products, fiscal year 1931*

Port	Seed cotton	Cottonseed hulls	Cottonseed cake	Cottonseed meal
Boston.....			4,000	86,000
Brownsville.....			193,000	
Calxico.....	¹ 808	¹ 9,296,942		
Detroit.....				19
El Paso.....				160,000
San Pedro.....				60,000
Yuma.....	¹ 315,475			
Total.....	316,283	9,296,942	197,000	306,019

¹ Entry of seed cotton and cottonseed hulls grown in the Imperial Valley, Lower California, Mexico, is allowed under permit.

The importations indicated in Tables 43 to 45 show a decrease from the importations of these commodities for the fiscal year 1930, as follows: Cotton, 66 per cent; cotton waste, 37 per cent; bagging, 20 per cent.

In addition, the administration supervised the entry of 519 packages of cotton samples imported by freight or express, 49 packages of cotton-waste samples imported by freight or express, and 13,412 packages of samples of cotton, cotton waste, and linters imported by parcel post.

IMPORTATIONS OF BROOMS, BROOMCORN, AND GRAIN

Tables 47 and 48 indicate, respectively, importations of brooms and broomcorn, and of clean shelled corn inspected under the provisions of quarantine No. 41. The quantity of shelled corn imported (Table 48) represents an increase of 805 per cent over last year's importations. Practically all this corn was shipped from Argentina. The importations of seeds other than corn imported under quarantine No. 41 also increased very materially. This year's importations are as follows: Grain sorghum, 19,980 pounds; Job's tears, 4,534 pounds; pearl millet, 10,910 pounds, and Sudan grass, 527,217 pounds.

TABLE 47.—*Importation of brooms and broomcorn under quarantine No. 41, by country of origin and port of entry, fiscal year 1931*

Country	Brooms			Broomcorn	
	Eagle Pass	New York	Total	Boston	Total
	Number	Number	Number	Bales	Bales
Argentina.....				62	62
Italy.....		50	50		
Mexico.....	264		264		
Rumania.....		51,837	51,837		
Total.....	264	51,887	52,151	62	62

TABLE 48.—*Importation, in bushels, of clean shelled corn under quarantine No. 41, by port of entry and country of growth, fiscal year 1931*

Port	Argentina	Bahama Islands	Canada	Union of South Africa	United States (returned)	Total
Baltimore.....	127,595					127,595
Bellingham.....	5,342					5,342
Boston.....	3,983					3,983
Detroit.....			7		219	226
Jacksonville.....	7,240					7,240
Los Angeles.....	38,646					38,646
Miami.....		72				72
New Orleans.....	223,751					223,751
New York.....	526,639			4		526,643
Norfolk.....	3,023					3,023
Philadelphia.....	233,267					233,267
Portau.....			4			4
Seattle.....	95,496					95,496
Tacoma.....	70,311					70,311
Total.....	1,335,293	72	11	4	219	1,335,599

In addition, the administration supervised the entry under quarantine No. 24 of 43,919 bushels of clean shelled corn from Manchuria: Arriving at San Francisco, 10,714 bushels; at Seattle, 33,205 bushels.

IMPORTATIONS OF FRUITS AND VEGETABLES

Tables 49 and 50 indicate the fruits and vegetables imported during the fiscal year under permit and subject to inspection at the port of first arrival under the provisions of quarantine No. 56; Table 49 by countries of origin, and Table 50 by ports of entry.

TABLE 49.—*Fruits and vegetables imported fiscal year 1931, by countries of origin*

[Imported under quarantine No. 56 unless otherwise designated]

Kind	Country and quantity	Total
Apple.....pounds..	England, 101; Netherlands, 50.....	151
Aralia cordata.....do..	China, 100.....	100
Arrowroot.....do..	Japan, 1,250.....	1,250
Artichoke.....do..	Mexico, 30.....	30
Asparagus.....do..	Argentina, 13,789; Mexico, 67,345.....	81,134
Avocado.....do..	Cuba, 9,749,250; Haiti, 90; Jamaica, 1,200; Mexico (seeds removed) 41,597.....	9,792,437
Balsam apple.....do..	Cuba, 5,053; Mexico, 130.....	5,183
Banana.....bunches..	Colombia, 815,763; Costa Rica, 3,441,456; Cuba, 3,655,701; Dominican Republic, 17; Guadeloupe, French West Indies, 140; Guatemala, 5,106,034; Haiti, 1,147; Honduras, 21,611,796; British Honduras, 88,228; Jamaica, 10,945,867; Mexico, 5,753,791; Nicaragua, 3,421,999; Panama (including Canal Zone), 4,775,781; Portugal, 1.....	59,617,726
Bean (green):		
Faba.....pounds..	Mexico, 18,352.....	18,352
Lima.....do..	Cuba, 3,759,567; Mexico, 249,850.....	4,009,417
String.....do..	Cuba, 258,816; Mexico, 1,907,451.....	2,166,267
Beet.....do..	Bermuda, 10; Mexico, 365,808.....	365,818
Berry (Rubus):		
Natural.....do..	Norway, 1,650.....	1,650
Frozen.....do..	England, 25,561; Scotland, 302,830.....	328,391
Brussels sprouts.....do..	France, 2,346.....	2,346
Burdock.....do..	Japan, 10,733.....	10,733
Cabbage.....do..	Cuba, 4,485; Germany, 35,684; Mexico, 43,901; Netherlands, 439,390.....	523,460
Cacao bean pod.....do..	Costa Rica, 425; Trinidad, British West Indies, 619.....	1,044
Carrot.....do..	Bermuda, 647; Mexico, 622,309; Netherlands, 450.....	623,406
Cassava.....do..	Cayman Islands, British West Indies, 350; China, 900; Cuba, 244,000; Dominican Republic, 325; St. Kitts, British West Indies, 5.....	245,780
Cauliflower.....do..	Belgium, 1,740; Mexico, 3,990.....	5,730
Celery.....do..	Bermuda, 1,158,830; Mexico, 6,540.....	1,165,370
Chayote.....do..	Cuba, 85,444; Mexico, 3,973.....	89,417
Cherry (dried, sour).....do..	Italy, 358,233; Yugoslavia, 950,850.....	1,309,083
Chinese watermelon.....do..	Cuba, 1,264.....	1,264
Cipollino.....do..	Italy, 59,815; Morocco (French), 2,977,713.....	3,037,528
Citrus medica.....do..	Cuba, 155; Italy, 2,411; Palestine, 20,515; Trinidad, British West Indies, 16.....	23,097
Clover top.....do..	Mexico, 872.....	872
Coriander.....do..	Mexico, 6.....	6
Crosnes.....do..	Belgium, 3,723.....	3,723
Cucumber.....do..	Bahamas, 40; Cuba, 3,339,538; Mexico, 57,174.....	3,396,752
Dasheen (includes colocasia, caladium, inhame, malanga, and taro), pounds.	Azores, 278,618; China, 846,524; Cuba, 354,257; Dominican Republic, 800,356; Japan, 213,500; Mexico, 28,208.....	2,521,463
Eggplant.....pounds..	Bahamas, 40; Cuba, 4,782,292; Mexico, 560,764.....	5,343,096
Endive.....do..	Belgium, 1,692,483; Mexico, 4.....	1,692,487
Garbanzo.....do..	Mexico, 232.....	232
Garlic.....do..	Azores, 264; Chile, 58,364; China, 1,000; Egypt, 22,160; Italy, 37,668; Mexico, 1,693,492.....	1,812,948
Ginger (crude).....do..	China, 466,044; Cuba, 54,612; Dominican Republic, 300; Japan, 650.....	521,606
Grape:		
Fresh (not hothouse).....do..	Argentina, 5,491,738; Chile, 97,278; Mexico, 1,433.....	5,590,449
Hothouse.....do..	Belgium, 222,979; England, 2; Netherlands, 200.....	223,181
Processed.....do..	Italy, 33,872.....	33,872
Grapefruit.....do..	Cuba, 9,193,267; Dominica, British West Indies, 70; Jamaica, 54,248.....	9,247,585
Horseradish.....do..	Germany, 38,220.....	38,220
Husk tomato.....do..	Mexico, 31,911.....	31,911
Jicama.....do..	Mexico, 3,573.....	3,573
Kale.....do..	Bermuda, 203,515.....	203,515
Kohlrabi.....do..	Mexico, 207.....	207
Kudzu.....do..	China, 113,079.....	113,079
Lemon.....crates.....	Azores, 1; Chile, 123; Cuba, 1; Italy, 387,397; Syria, 1.....	387,523
Lettuce.....pounds..	Bermuda, 10; Mexico, 72,738.....	72,748
Lily bulbs (edible).....do..	China, 45,876; Japan, 2,000.....	47,876
Lime (sour).....do..	Antigua, British West Indies, 6,750; Costa Rica, 39,255; Cuba, 6,515; Dominica, British West Indies, 1,979,595; Dominican Republic, 7,950; Grenada, British West Indies, 1,450; Honduras, 933; Jamaica, 504,106; Mexico, 3,538,469; St. Kitts, British West Indies, 1,550; St. Lucia, British West Indies, 475,473; St. Vincent, British West Indies, 3,455; Trinidad, British West Indies, 21,791; Virgin Islands, 840.....	6,588,132
Melon.....do..	Argentina, 52,740; Chile, 7,338,396; Cuba, 42; Italy, 1,984; Mexico, 45,908; Portugal, 7,650; Spain, 518,805.....	7,965,525

TABLE 49.—*Fruits and vegetables imported fiscal year 1931, by countries of origin—Continued*

Kind	Country and quantity	Total
Mint.....pounds	Bermuda, 990; Mexico, 293.....	1,283
Mushroom.....do	Japan, 1,000.....	1,000
Mushroom spawn.....do	England, 2,566; Japan, 9.....	2,575
Mustard.....do	Mexico, 60,810.....	60,810
Nectarine.....do	Belgium, 138; Chile, 50,559.....	50,697
Nuts (in the shell):		
Acorn.....do	Greece, 2,347,450; Turkey, 15,300,988.....	17,648,438
Chestnut.....do	China, 6,280; France, 1,626; Italy, 16,419,506; Japan, 401,765; Portugal, 870,334; Spain, 407,595; Sweden, 7.....	18,107,113
Okra.....do	Cuba, 1,788,947; Mexico, 2,749.....	1,791,696
Olive.....do	Mexico, 25.....	25
Onion.....do	Argentina, 100; Australia, 49,500; Azores, 15; Bermuda, 1,420; Chile, 572,384; China, 260; Egypt, 12,100; Italy, 2,016,977; Mexico, 271,939; Morocco (French), 50; Netherlands, 35,840; Spain, 10,236,272.....	13,196,857
Orange:		
Under quarantine No. 56, pounds.	Cuba, 179,151; Dominican Republic, 1,400; Jamaica, 23,380.....	203,931
Mandarin (quarantine No. 28), pounds.	Japan, 1,917,540.....	1,917,540
Pachyrhizus.....pounds	China, 43,800.....	43,800
Parsley.....do	Bermuda, 67,003; Cuba, 195; Mexico, 27,968.....	95,166
Pea.....do	Cuba, 115; Mexico, 18,874,816.....	18,874,931
Peach.....do	Argentina, 5,980; Belgium, 578; Chile, 77,339.....	83,897
Pear.....do	Netherlands, 50.....	50
Pepper.....do	Bahamas, 3,094; Cuba, 3,058,898; Haiti, 350; Mexico, 6,054,766.....	9,117,108
Pigeon pea.....do	Cuba, 1,299.....	1,299
Pigweed.....do	Mexico, 1,191.....	1,191
Pineapple.....crates	Azores, 46; Costa Rica, 2; Cuba, 1,177,129; Ecuador, 1; Guadeloupe, French West Indies, 10; Honduras, 389; Jamaica, 1; Mexico, 4,062.....	1,181,640
Plantain.....pounds	Cuba, 5,351,353; Dominican Republic, 189,848; Honduras, 179,317; Jamaica, 1,055; Mexico, 12,130; Nicaragua, 20,000; Panama (including Canal Zone), 781,413; Venezuela, 120.....	6,535,236
Plum.....do	Chile, 28,065.....	28,065
Potato:		
Under quarantine No. 56, pounds.	Bermuda, 2,333,987.....	2,333,987
Under potato regulations (order of Dec. 22, 1913), pounds.	Cuba, 3,985,006; Mexico, 262,204.....	4,247,210
Prickly pear.....pounds	Mexico, 5,401.....	5,401
Pumpkin.....do	Cuba, 45,970; Dominican Republic, 71,633; Mexico, 18,475.....	136,078
Purslane.....do	Mexico, 600.....	600
Radish.....do	Mexico, 100,190.....	100,190
St. John's bread.....do	Cyprus, 448,000; Italy, 407,747; Sicily, 2,240.....	857,987
Shallot.....do	Netherlands, 17,920.....	17,920
Sorrel.....do	Bermuda, 170.....	170
Spinach.....do	Cuba, 3,772; Mexico, 106,774.....	110,546
Squash.....do	Bermuda, 9; Cuba, 153,216; Mexico, 177,876.....	331,101
Strawberry.....do	Mexico, 15.....	15
Swiss chard.....do	Mexico, 6,842.....	6,842
Tamarind bean pod.....do	Antigua, British West Indies, 34,345; Cuba, 3,120; India, 56,000; Mexico, 1,573; Nevis, British West Indies, 18,748; St. Kitts, British West Indies, 5; Virgin Islands, 1,665.....	115,456
Tarragon.....do	Bermuda, 140.....	140
Tomato.....pounds	Algeria, 2,727; Bahamas, 4,053,027; Canary Islands, 73,168; Cuba, 21,550,833; England, 30; Guernsey, Channel Islands, 2,400; Haiti, 35,225; Mexico, 84,770,581; Nevis, British West Indies, 120.....	116,488,111
Turnip.....do	Bermuda, 50; Cuba, 3,097; Mexico, 363,435.....	366,582
Vaccinium (cranberry, etc.):		
Natural.....pounds	England, 30; Newfoundland, 686,081; Norway, 53,243; Sweden, 180.....	739,534
Frozen.....do	Newfoundland, 3,472,280.....	3,472,280
Waterchestnut.....do	China, 1,687,589.....	1,687,589
Water cress.....do	Mexico, 12,566.....	12,566
Waterlily root.....do	China, 17,983; Cuba, 22,162.....	40,145
Watermelon.....do	Cuba, 322,419; Italy, 90; Mexico, 238,502.....	561,011

TABLE 50.—*Fruits and vegetables imported fiscal year 1931, by ports of entry*

[Imported under quarantine No. 56 unless otherwise designated]

Kind	Port and quantity	Total
Apple.....pounds..	New York, 151.....	151
Aralia cordata.....do..	San Francisco, 100.....	100
Arrowroot.....do..	Seattle, 1,250.....	1,250
Artichoke.....do..	Naco, 30.....	30
Asparagus.....do..	Calexico, 9; New York, 13,789; San Ysidro, 67,336.....	81,134
Avocado.....do..	Brownsville (seeds removed), 311; Douglas (seeds removed), 142; Eagle Pass (seeds removed), 3,799; El Paso (seeds removed), 9,398; Hidalgo (seeds removed), 5,379; Key West, 1,603,365; Laredo (seeds removed), 19,190; Miami, 66,575; New Orleans, 2,377,542; New York, 3,161,541; Nogales (seeds removed), 3,678; Tampa, 2,541,517.....	9,792,437
Balsam apple.....do..	New York, 5,053; Nogales, 130.....	5,183
Banana.....bunches..	Baltimore, 3,268,458; Boston, 3,350,093; Brownsville, 4,545; Calais, Me., 145; Cannons Corners, N. Y., 194; Charleston, 939,687; Detroit, 14,210; Eagle Pass, 2,081; Eastport, Me., 248; El Paso, 1,043,642; Galveston, 2,018,872; Hidalgo, 1,019; Jacksonville, 258,297; Key West, 5,971; Laredo, 222,074; Los Angeles, 1,755,982; Miami, 154,286; Mobile, 2,425,674; New Orleans, 17,863,031; New York, 18,480,016; Niagara Falls, 375; Nogales, 2,513; North Troy, Vt., 36; Philadelphia, 5,310,413; Providence, 1; Rouses Point, N. Y., 32; San Francisco, 1,780,835; Sault Ste. Marie, 1,840; Tampa, 712,701; Trout River, N. Y., 455.....	59,617,726
Bean (green):		
Faba.....pounds..	Nogales, 18,352.....	18,352
Lima.....do..	El Paso, 54; Laredo, 4,687; New York, 3,759,567; Nogales, 193,005; San Ysidro, 52,104.....	4,009,417
String.....do..	Brownsville, 220,621; Calexico, 930; Douglas, 9,064; Eagle Pass, 3,378; El Paso, 107,135; Laredo, 527,296; Naco, 1,976; New York, 258,816; Nogales, 848,581; San Ysidro, 188,470.....	2,166,267
Beet.....do..	Calexico, 661; Douglas, 31,397; Eagle Pass, 112; El Paso, 312,250; Naco, 4,131; New York, 10; Nogales, 17,257.....	365,818
Berry (Rubus):		
Natural.....do..	New York, 1,650.....	1,650
Frozen.....do..	New York, 328,391.....	328,391
Brussels sprouts.....do..	New York, 2,346.....	2,346
Burdock.....do..	Los Angeles, 10,233; New York, 500.....	10,733
Cabbage.....do..	Calexico, 664; Douglas, 20,066; Eagle Pass, 150; El Paso, 147; Key West, 100; Laredo, 50; Naco, 2,736; New York, 479,109; Nogales, 20,088; Tampa, 350.....	523,460
Cacao bean pod.....do..	New York, 1,044.....	1,044
Carrot.....do..	Calexico, 1,200; Douglas, 39,511; Eagle Pass, 401; El Paso, 541,077; Naco, 6,070; New York, 1,097; Nogales, 34,050.....	623,406
Cassava.....do..	Chicago, 900; Key West, 18,229; New York, 191,699; Tampa, 34,952.....	245,780
Cauliflower.....do..	Calexico, 1; Douglas, 792; Naco, 452; New York, 1,740; Nogales, 2,745.....	5,730
Celery.....do..	Calexico, 5; Douglas, 5,814; Naco, 457; New York, 1,158,830; Nogales, 264.....	1,165,370
Chayote.....do..	El Paso, 2,626; Key West, 200; Laredo, 1,210; New Orleans, 30,465; New York, 54,779; Nogales, 137.....	89,417
Cherry (dried, sour).....do..	Boston, 93,536; New York, 1,106,484; Philadelphia, 109,063.....	1,309,083
Chinese watermelon.....do..	New York, 1,264.....	1,264
Cipollino.....do..	Boston, 10,924; New York, 2,983,862; Philadelphia, 42,718; San Francisco, 24.....	3,037,528
Citrus medica.....do..	Detroit, 165; New York, 22,932.....	23,097
Clover top.....do..	Douglas, 681; Naco, 185; Nogales, 6.....	872
Coriander.....do..	Calexico, 6.....	6
Crosnes.....do..	New York, 3,723.....	3,723
Cucumber.....do..	Baltimore, 6,764; Brownsville, 25; Calexico, 1,121; Douglas, 6,164; El Paso, 100; Key West, 264,000; Laredo, 50; Naco, 863; New Orleans, 10,755; New York, 3,054,916; Nogales, 48,851; Tampa, 3,143.....	3,396,752
Dasheen (includes colocasia, caladium, inhame, malanga, and taro), pounds.	Boston, 33,044; Buffalo, 39,124; Calexico, 25,953; Chicago, 10,150; Detroit, 2,500; Key West, 24,888; Los Angeles, 50,100; New York, 1,155,985; Nogales, 5; Philadelphia, 2,500; Pittsburgh, 1,000; Portland, 3,820; Providence, 276,643; San Francisco, 716,110; San Ysidro, 2,250; Seattle, 118,595; Tampa, 58,796.....	2,521,463
Eggplant.....pounds..	Baltimore, 31,008; Brownsville, 9,488; Calexico, 170; Douglas, 2,325; El Paso, 1,217; Key West, 265,133; Laredo, 12,501; Naco, 163; New Orleans, 408,625; New York, 4,074,619; Nogales, 534,900; Tampa, 2,947.....	5,343,096
Endive.....do..	Calexico, 4; New York, 1,692,483.....	1,692,487
Garbanzo.....do..	Brownsville, 200; Eagle Pass, 32.....	232
Garlic.....do..	Boston, 22,160; Brownsville, 675; Calexico, 50,482; Douglas, 5,394; Eagle Pass, 5,497; El Paso, 28,042; Hidalgo, 570; Laredo, 664,831; Los Angeles, 3,100; Naco, 824; New Orleans, 2,396; New York, 1,004,134; Nogales, 22,579; Providence, 264; San Francisco, 2,000.....	1,812,948

TABLE 50.—*Fruits and vegetables imported fiscal year 1931, by ports of entry—Continued*

Kind	Port and quantity	Total
Ginger (crude).....pounds..	Boston, 15,540; Buffalo, 22,490; Chicago, 7,650; Detroit, 300; Los Angeles, 17,228; New York, 117,221; Pittsburgh, 500; Portland, 640; San Francisco, 320,521; Seattle, 19,516.	521, 006
Grape:		
Fresh (not hothouse), pounds.....	Calexico, 121; Eagle Pass, 577; Laredo, 675; New York, 5,589,016; Nogales, 60.	5, 590, 449
Hothouse.....do.....	New York, 223,181	223, 181
Processed.....do.....	New York, 33,872	33, 872
Grapefruit.....do.....	Boston, 11,470; Chicago, 599,742; Cincinnati, 779,140; New York, 6,802,005; Philadelphia, 1,398; St. Louis, 1,053,830.	9, 247, 585
Horseradish.....do.....	Boston, 1,496; New York, 36,724	38, 220
Husk tomato.....do.....	Brownsville, 2,190; Calexico, 2; El Paso, 28,639; Hidalgo, 1,080	31, 911
Jicama.....do.....	El Paso, 2,973; Laredo, 600	3, 573
Kale.....do.....	New York, 203,515	203, 515
Kohlrabi.....do.....	Calexico, 11; El Paso, 80; Naco, 80; Nogales, 36	207
Kudzu.....do.....	Boston, 6,910; Buffalo, 11,064; Detroit, 400; Los Angeles, 10,110; New York, 22,400; Pittsburgh, 500; Portland, 400; San Francisco, 55,248; Seattle, 6,047.	113, 079
Lemon.....crates.....	Boston, 1,269; New Orleans, 44,885; New York, 341,058; Pensacola, 150; Philadelphia, 160; Providence, 1.	387, 523
Lettuce.....pounds.....	Calexico, 527; Douglas, 34,890; Eagle Pass, 1,033; El Paso, 1,019; New York, 7,288; New York, 10; Nogales, 27,981.	72, 748
Lily bulb (edible).....do.....	Boston, 6,630; Buffalo, 6,000; Chicago, 100; Detroit, 100; Los Angeles, 2,200; New York, 11,830; Pittsburgh, 500; Portland, 200; San Francisco, 18,404; Seattle, 1,912.	47, 876
Lime (sour).....do.....	Baltimore, 3,990; Boston, 40,829; Brownsville, 14,405; Eagle Pass, 634,295; El Paso, 216,212; Hidalgo, 480; Laredo, 2,108,296; Los Angeles, 500,057; New Orleans, 144,918; New York, 2,862,145; Nogales, 5,790; San Francisco, 6,715.	6, 588, 132
Melon.....do.....	Boston, 8,250; Calexico, 596; Douglas, 98; Eagle Pass, 137; Laredo, 150; Naco, 335; New York, 7,911,367; Nogales, 44,592.	7, 965, 525
Mint.....do.....	Calexico, 233; El Paso, 60; New York, 990	1, 283
Mushroom.....do.....	San Francisco, 1,000	1, 000
Mushroom spawn.....do.....	Baltimore, 2,558; San Francisco, 17	2, 575
Mustard.....do.....	Calexico, 7,723; Douglas, 17,963; El Paso, 28,157; Naco, 5; Nogales, 6,962.	60, 810
Nectarine.....do.....	New York, 50,697	50, 697
Nuts (in the shell):		
Acorn.....do.....	New York, 16,132,838; Norfolk, 215,200; Philadelphia, 1,300,400.	17, 648, 438
Chestnut.....do.....	Boston, 180; Los Angeles, 137,325; New York, 17,719,660; Philadelphia, 427; San Francisco, 174,721; Seattle, 74,800.	18, 107, 113
Okra.....do.....	Baltimore, 892; Key West, 25,870; New Orleans, 798,100; New York, 653,784; Nogales, 2,749; Tampa, 308,301.	1, 791, 696
Olive.....do.....	Laredo, 25	25
Onion.....do.....	Boston, 757,408; Calexico, 3,100; Douglas, 80,770; Eagle Pass, 928; Eastport, Me., 200; El Paso, 148,274; Naco, 9,380; New York, 12,117,429; Nogales, 29,487; Providence, 121; San Francisco, 260; Seattle, 49,500.	13, 196, 857
Orange:		
Under Quarantine No. 56, pounds.....	Boston, 13,270; Chicago, 68,068; New York, 122,593	203, 931
Mandarin (Quarantine No. 28), pounds.....	Seattle, 1,917,540	1, 917, 540
Pachyrhizus.....pounds.....	Los Angeles, 14,200; San Francisco, 29,600	43, 800
Parsley.....do.....	Calexico, 12; Douglas, 1,989; El Paso, 25,350; Naco, 149; New York, 67,063; New Orleans, 135; Nogales, 468.	95, 166
Pea.....do.....	Brownsville, 6,609; Calexico, 1,555; Douglas, 1,926; Eagle Pass, 1,229; El Paso, 75; Laredo, 11,867; Naco, 1,144; New York, 115; Nogales, 18,812,926; San Francisco, 16,800; San Ysidro, 20,685.	18, 874, 931
Peach.....do.....	New York, 83,897	83, 897
Pear.....do.....	New Orleans, 50	50
Pepper.....do.....	Baltimore, 7,716; Brownsville, 98,231; Calexico, 514; Del Rio, 14,703; Douglas, 40,940; Eagle Pass, 79,664; El Paso, 309,699; Hidalgo, 5,739; Key West, 125,010; Laredo, 135,199; Los Angeles, 13,350; Naco, 5,515; New Orleans, 165,240; New York, 2,762,546; Nogales, 5,217,983; Presidio, 329; San Francisco, 132,900; Tampa, 1,830.	9, 117, 108
Pigeon pea.....do.....	New York, 1,299	1, 299
Pigweed.....do.....	Douglas, 1,161; Naco, 12; Nogales, 18	1, 191
Pineapple.....crates.....	Baltimore, 12,600; Boston, 1; Brownsville, 12; Douglas, 1; Eagle Pass, 1; El Paso, 2,427; Key West, 795,376; Laredo, 1,582; Los Angeles, 300; Miami, 1,035; Mobile, 31; Naco, 1; New Orleans, 72,338; New York, 283,693; Nogales, 38; Providence, 45; San Francisco, 500; Tampa, 11,659.	1, 181, 640
Plantain.....pounds.....	Baltimore, 278,000; Boston, 795; Charleston, 23,540; Key West, 607,438; Miami, 138,813; Mobile, 546,143; New Orleans, 352,389; New York, 3,339,831; Philadelphia, 101,622; Tampa, 1,146,665.	6, 535, 236

TABLE 50.—*Fruits and vegetables imported fiscal year 1931, by ports of entry—Continued*

Kind	Port and quantity	Total
Plum.....pounds..	New York, 28,065.....	28, 065
Potato:		
Under Quarantine No. 56, pounds.	New York, 2,333,987.....	2, 333, 987
Under potato regulations (order of Dec. 22, 1913), pounds.	Douglas, 135,939; Key West, 159,820; Naco, 26,771; New York, 3,825,186; Nogales, 99,494.....	4, 247, 210
Prickly pear.....pounds..	Calexico, 1; El Paso, 3,059; Laredo, 2,335; Nogales, 6.....	5, 401
Pumpkin.....do.....	Calexico, 1,056; Douglas, 6,027; Eagle Pass, 3,853; Key West, 15,650; Laredo, 5,003; Naco, 489; New York, 97,938; Nogales, 47; Tampa, 4,015; Zapata, 2,000.....	136, 078
Purslane.....do.....	Naco, 59; Nogales, 541.....	600
Radish.....do.....	Calexico, 961; Douglas, 14,567; Eagle Pass, 21; El Paso, 76,163; Naco, 1,746; Nogales, 6,732.....	100, 190
St. John's bread.....do.....	New York, 857,987.....	857, 987
Shallot.....do.....	New York, 17,920.....	17, 920
Sorrel.....do.....	New York, 170.....	170
Spinach.....do.....	Calexico, 897; Douglas, 29,199; El Paso, 45,795; Naco, 5,226; New York, 3,772; Nogales, 25,657.....	110, 546
Squash.....do.....	Baltimore, 1,572; Brownsville, 2,767; Calexico, 1,715; Douglas, 14,138; Eagle Pass, 351; El Paso, 80,244; Key West, 180; Laredo, 28,199; Naco, 1,897; New Orleans, 3,600; New York, 147,873; Nogales, 32,665; San Ysidro, 15,900.....	331, 101
Strawberry.....do.....	Nogales, 15.....	15
Swiss chard.....do.....	El Paso, 6,842.....	6, 842
Tamarind bean pod.....do.....	Calexico, 3; El Paso, 100; Laredo, 1,470; New York, 113,883.....	115, 456
Tarragon.....do.....	New York, 140.....	140
Tomato.....do.....	Baltimore, 22,163; Boston, 233,790; Brownsville, 22,551; Buffalo, 220,800; Calexico, 3,117; Chicago, 19,600; Del Rio, 1,680; Detroit, 136,080; Douglas, 40,981; Eagle Pass, 32,923; El Paso, 215,830; Hidalgo, 820; Key West, 3,378,300; Laredo, 191,064; Los Angeles, 3,177,028; Mercedes, 235; Miami, 649,030; Naco, 5,560; New Orleans, 1,487,350; New York, 25,751,497; Nogales, 77,849,936; Port Huron, 246,000; Presidio, 752; Rouses Point, N. Y., 33,560; San Francisco, 2,762,241; San Ysidro, 138; Tampa, 5,085.....	116, 488, 111
Turnip.....do.....	Calexico, 856; Douglas, 28,144; El Paso, 319,494; Naco, 2,923; New York, 3,147; Nogales, 12,018.....	366, 582
Vaccinium (cranberry, etc.):		
Natural.....pounds..	Boston, 93,725; New York, 645,629; San Francisco, 180.....	739, 534
Frozen.....do.....	Boston, 1,053,750; New York, 2,418,530.....	3, 472, 280
Waterchestnut.....do.....	Boston, 68,698; Buffalo, 139,883; Chicago, 116,100; Detroit, 14,000; Los Angeles, 116,200; New York, 344,039; Pittsburgh, 1,500; Portland, 2,200; San Francisco, 617,160; Seattle, 267,809.....	1, 687, 589
Water cress.....do.....	Calexico, 308; Douglas, 8,339; Eagle Pass, 19; Naco, 1,204; Nogales, 2,696.....	12, 566
Waterlily root.....do.....	Boston, 1,700; Chicago, 160; New York, 22,362; San Francisco, 6,500; Seattle, 9,423.....	40, 145
Watermelon.....do.....	Calexico, 2,336; Douglas, 2,911; El Paso, 850; Fabens, 322; Hidalgo, 26,000; Key West, 154,340; Naco, 2,585; New Orleans, 50,394; New York, 117,775; Nogales, 197,998; Zapata, 5,500.....	561, 011

In the annual report for last year attention was drawn for the first time to marked fluctuations in the importation of some of the more important fruits and vegetables, although the aggregate net increase of such imports as compared with those of the preceding year was only 6.4 per cent. Omitting the items bananas, lemons, pineapples, and plantains, for which different units of quantity are employed, the imports of fresh fruits and vegetables show an aggregate net decrease of 34.5 per cent as compared with those of the fiscal year 1930, namely, 282,120,429 pounds in 1931 as against 430,827,038 pounds in 1930. Among the products showing an increase of more than 20 per cent during the fiscal year 1931 are the following: Asparagus, 183 per cent; avocados, 45 per cent; beans (Lima), 23 per cent; cucumbers, 85 per cent; melons, 53 per cent. Among those showing a greater decrease than 20 per cent are: Acorns, 30 per cent; beans (faba), 73 per cent; beans (string), 37 per cent; beets, 54 per cent; cabbage, 99 per cent; carrots, 76 per cent; celery, 55 per cent; eggplants, 29

per cent; garlic, 30 per cent; grapes (fresh), 22 per cent; horseradish, 99 per cent; lemons, 65 per cent; onions, 76 per cent; oranges (under quarantine No. 56), 73 per cent; peas, 37 per cent; peppers, 36 per cent; potatoes (quarantine No. 56), 39 per cent; potatoes (potato regulations), 66 per cent.

PLANTS AND PLANT PRODUCTS ENTERED FOR IMMEDIATE EXPORTATION OR FOR IMMEDIATE TRANSPORTATION AND EXPORTATION IN BOND

In addition to the regulated imports for consumption entry recorded in Tables 34-50, the administration supervised the entry under permit, either for immediate exportation or for immediate transportation and exportation in bond, of considerable quantities of plants and plant products. Among the principal items may be mentioned 1,425,098 bulbs, 10,000 convallaria pips, 62,252 fruit cuttings, fruit trees, and roses, 18,939 cacti, 10,070 orchids, 33,902 miscellaneous plants, shrubs, and trees, 91,800 pounds of acorns, 226,291 pounds of apples, 12,669,507 pounds of citrus fruits, 2,252,766 pounds of garlic, 69,280 pounds of ginger, 49,562 pounds of melons, 15,987,574 pounds of onions, 310,761 pounds of peas, 32,562 pounds of peppers, 5,036,741 pounds of potatoes, 12,569,190 pounds of tomatoes, 114,727 crates of pineapples, 56,257 pounds of miscellaneous fruits and vegetables, 98,843 bales of cotton, 255 bales of cotton waste, 20 bales of bagging, 7,310 pounds of cottonseed, 50,000 pounds of cottonseed meal, 189,934 pounds of cottonseed cake, 84,546 bushels of corn, 30 pounds of Job's tears, 467 pounds of wheat, 5,000 pounds of wheat products (middlings), and 428,163 pounds of seed or paddy rice.

CERTIFICATION FOR EXPORT

In order to meet the inspection and certification requirements of various foreign countries as a condition for the entry of plants and plant products into these countries from the United States, provisions are made for such required inspection and certification under the "rules and regulations of the Secretary of Agriculture governing the inspection and certification of plants and plant products offered for export to meet the sanitary requirements of foreign countries." Such service is furnished on the payment of fees covering the cost of inspection. A total of \$13,443.90 was collected in fees under the provisions of these regulations and covered into the Treasury. Over 5,000 shipments of products were inspected and certified, most of the work being conducted at the ports of Mobile, New Orleans, New York, Portland (Oreg.), San Francisco, and Seattle.

TECHNOLOGICAL DIVISION

The work of this division is largely cooperative with the other divisions and projects of the administration on problems concerned with sterilization and disinfection of plants and plant products under regulation.

DEVELOPMENT OF METHODS OF HEAT STERILIZATION

Methods of heat sterilization for avocados were developed in Florida and applied on a commercial basis during the early part of the 1930 shipping season. In all, 417 crates of avocados were sterilized during that portion of the shipping season in which the Mediter-

anean fruit-fly quarantine was operative in regulating the shipment of fruits. The prices received for this sterilized fruit were as high or higher than those for unsterilized avocados shipped from the same section.

During the summer and fall of 1930, in cooperation with the Bureaus of Entomology and Plant Industry, considerable test work was carried on to determine the effect of the heat method of sterilization on various fruits and vegetables in Florida, California, and the lower Rio Grande Valley of Texas. The purpose of this work was to develop, if possible, a method of sterilizing these commodities which would be available if further infestation of the Mediterranean fruit fly appeared in the continental United States, or if such methods of sterilization were needed for some other pest. Tests were carried out on 16 different fruits, vegetables, and nuts in Florida and 23 in California. In most cases a number of varieties of the different kinds of fruits or vegetables were tested. The work in the lower Rio Grande Valley was confined altogether to the treatment of citrus fruit. The results of these tests indicate that this method of sterilization can be applied to many fruits and vegetables without apparent injury to their attractiveness and desirability for food purposes. It can be used in the sterilization of citrus fruit in the lower Rio Grande Valley if it becomes necessary in connection with an infestation of the Mexican fruit worm.

COTTONSEED STERILIZATION

A method of sterilizing cottonseed for use as seed, which promises to be effective in destroying all pink-bollworm larvae present in infested seed, was developed during the past season. It consists of heating the seed to 145° F. in a commercial sterilizer and then placing it in a steam jacketed container for a period of about one hour, allowing the seed to come to a constant temperature throughout the entire mass. With tests on infested seed under commercial conditions, it was found that this method apparently destroyed all pink-bollworm larvae during that period. Tests were also carried out in fumigating cottonseed with hydrocyanic acid under reduced pressure. This treatment promises to be effective in destroying any pink bollworm larvae which might be present.

COMPRESSION OF COTTON

During the past year, tests were made on the effect of compression, as applied in the standard commercial cotton compress developing about 450 tons pressure, in destroying the larvae of the pink bollworm in infested seed within the bale. These tests were made by placing within the bale a sheet of cloth on which infested cottonseed had been glued at regular intervals. The cloth was so placed that the seeds were evenly spaced throughout the cross section of the bale. Pressure was applied to the bale in the usual manner, then released. The sheeting with the seeds attached was removed from the bale and the seeds examined to determine the effect of the compression on the larvae within them. It was found that under standard compression 84 per cent of the larvae within the bale were killed and that under high-density compression about 93 per cent of the larvae were killed. This work, combined with data accumulated in the pink-bollworm project

of the administration on the average number of cottonseeds per bale in cotton, and the average number of infested seed in cottonseed from various gins in the regulated area, made possible the determination of the possibility of live pink bollworm occurring in a bale of cotton after compression. It was shown that in some of the regulated regions, where the insect population had been reduced by effective control measures, there was only about one chance in 50,000 of a live pink bollworm occurring in a bale of cotton after compression.

CAR FUMIGATION

An extended series of tests was carried on in the fumigation of freight cars on the Mexican border. Forty-three were made inside the car-fumigation house at El Paso, using two cars in every test, and 21 were made with single cars outside the fumigation house. The results of these tests demonstrated that even under adverse weather conditions it is possible to destroy all pink-bollworm larvae in infested cottonseed which might be present in refuse in the car by proper application of sufficient dosage of hydrocyanic acid gas. Some changes in the present method of applying gas to make the treatment more effective were developed.

DESIGNING AND CONSTRUCTION WORK

During the past year, a fumigation house for fumigating railroad cars was designed, the plans drawn, specifications prepared, and the construction supervised. The house, which is located at Presidio, Tex., was constructed at a cost of about \$20,000. It has a capacity of six freight cars at one time and is equipped with a new type door which is believed to be gas tight and has several other features. Repairs to other fumigation houses and improvements in equipment have been designed and installed during the year.

An incinerator, constructed of brick, lined with fire brick, having a cast-iron grate, and using kerosene as a fuel, was designed and tested, and 20 units are being constructed at the Mexican border ports of entry. The cost of the incinerator is \$76.

REVISED PLANT QUARANTINES AND MISCELLANEOUS REGULATIONS

A condensed record of revisions and revocations of quarantines and miscellaneous regulations during the year is given below.

DOMESTIC QUARANTINES

The European corn-borer quarantine regulations were amended July 30, 1930, by adding the northern half of the State of New Hampshire to the area regulated on account of the 2-generation strain of the borer, thus bringing the entire State under regulation; on August 16, 1930, the regulations were further amended by (1) removing all restrictions on the interstate shipment of oat and rye straw, celery, and cut flowers or entire plants of cosmos, zinnia, and hollyhock, from the 2-generation area of eastern New England, and (2) discontinuing, as to both the 1-generation and the 2-generation areas, the requirement of certification of clean shelled corn and clean seed of broomcorn, sorghums, and Sudan grass; on January 19, 1931, the regulations were revised by extending slightly both the 1-generation

and the 2-generation regulated areas, transferring from the 1-generation to the 2-generation regulated area certain portions of Massachusetts, New Jersey, and New York, including all of New York City, and releasing from restriction part of one county in New Jersey and two entire counties in New York, and by removing restrictions on the shipment of (1) ear corn from the 1-generation area to the 2-generation area where such areas are contiguous in New England and New York, (2) green corn on the cob from the 2-generation area to outside points during the period from January 1 to June 14, inclusive, when no green corn of local production is available, and (3) string beans and wax beans from the 2-generation regulated area to outside points.

The Japanese-beetle quarantine and regulations were revised November 3, 1930, by transferring the District of Columbia and small sections of Virginia and Pennsylvania from the lightly infested to the generally infested area; by transferring parts of Baltimore and Harford Counties, Md., from the generally infested to the lightly infested area; by adding to the lightly infested area the State of Rhode Island and small sections of Delaware, Massachusetts, New York, Pennsylvania, and Virginia, and by exempting from the requirement of certification farm products moving from the vicinity of Washington, D. C.; on May 21, 1931, the regulations were amended by modifying the plan of classification of nurseries, greenhouses, and other premises concerned in the movement of nursery and ornamental stock with the object of relieving nurserymen and florists of some of the difficulties of compliance with the quarantine requirements without involving increase in risk of spread of the beetle.

The Mediterranean fruit fly quarantine regulations were modified by administrative instructions on July 24, 1930, by authorizing the movement of sterilized avocados from Florida to other Southern and Western States, and by extending the production and harvesting period of Florida grapes; the regulations were revised August 9, 1930, effective August 15, 1930, by (1) authorizing the movement of sterilized fruit and of unsterilized tomatoes, eggplants, and Lima and broad beans from the regulated area of Florida to the Southern and Western States throughout the entire shipping season or until further notice; (2) authorizing the State plant board to reduce the size of the infested area to include properties within one-half (in place of 1) mile from points of infestation; (3) discontinuing the requirement of sterilization for fruit shipped to the Middle Western States from points outside the infested areas; (4) adding blackberries, dewberries, mulberries, cotton bolls, and seed cotton to the list of products which are exempt from the fruit-fly requirements; (5) extending the harvesting and marketing period of the commercial Florida citrus crop to June 15, 1931; and (6) removing the reshipment regulations under which the transportation of Florida host fruits and vegetables from the Northeastern States to the Middle West was restricted; the revised regulations were modified by administrative instructions on August 21, 1930, by authorizing the use of prescribed methods of sterilizing grapefruit, oranges, tangerines, Satsumas, and avocados by heat, and grapefruit, oranges, tangerines, and Satsumas by refrigeration; the revised regulations were amended September 30, 1930, effective October 15, 1930, by (1) removing the sterilization requirements

formerly prescribed for host fruits and vegetables moved interstate from all those parts of Florida not included in infested areas to Southern and Western States, (2) modifying regulation 11 to remove the restrictions as to cleaning railway cars, boats, and other vehicles which have been used in transporting the restricted articles out of the regulated area, and (3) providing for the unrestricted reshipment from Northern to Southern and Western States of host fruits and vegetables which have originated in and been moved from the regulated area in Florida; on October 14, 1930, effective October 15, 1930, by releasing from restriction that part of the State of Florida lying between the Aucilla River on the east and the Ocklockonee River on the west, comprising the counties of Jefferson, Leon, and Wakulla, and by removing restrictions on the shipment of host vegetables produced outside of infested areas; on November 1, 1930, effective November 5, 1930, by removing the prohibition against the transportation of host fruits from the regulated area of Florida by trucks and other road vehicles, and by authorizing such movement under proper controls; and on November 11, 1930, effective November 15, 1930, the quarantine was lifted.

The pink-bollworm quarantine regulations were modified by administrative instructions on October 17, 1930, by requiring fumigation of cotton lint produced in Eddy and Otero Counties, N. Mex., for movement to points outside the regulated area; they were amended November 15, 1930, by releasing from restriction the counties of Martin and Glasscock, the formerly regulated portions of Dawson, Howard, and Borden Counties, and a small portion of the northeast corner of Midland County, Tex.; they were modified by administrative instructions on November 17, 1930, by requiring fumigation of cotton lint produced in Chaves County, N. Mex., for movement to points outside the regulated area.

The satin-moth quarantine regulations were amended January 19, 1931, effective February 1, 1931, by the addition to the regulated area of 177 towns in Maine, 21 towns in New Hampshire, 10 towns in Vermont, 21 towns in Massachusetts, and 38 towns in Connecticut.

The black stem rust quarantine was revised June 24, 1931, effective August 1, 1931, by extending the quarantine to the States of Colorado, Illinois, Indiana, Iowa, Minnesota, Michigan, Montana, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin, and Wyoming, and by restricting the shipment into and between these 13 protected States, which are engaged in barberry eradication, of *Berberis* and *Mahonia* (except the Japanese barberry, an immune species) from all States of the continental United States and from the District of Columbia.

The gipsy-moth and brown-tail moth quarantine regulations were revised May 25, 1931, effective June 1, 1931, by clarifying the definition of restricted articles, by authorizing the recognition of valid State nursery inspection certificates as evidence of freedom from brown-tail moth with respect to certain shipments of deciduous trees and shrubs moving to points within the gipsy-moth infested areas, and by removing the embargo against the interstate movement from the generally infested area of certain classes of Christmas greenery, such as holly and laurel.

FOREIGN QUARANTINES

The nursery stock, plant, and seed quarantine regulations were revised December 17, 1930, by providing for the exclusion of elm (*Ulmus* spp.) seed from Europe, for the freedom from pulp of the nuts and seeds enumerated in regulation 3, and for the importation of the plant material permitted entry under said regulation from countries not maintaining inspection for public service purposes instead of for experimental purposes only. The single amendment promulgated since the issuance of the last edition, was incorporated, several minor changes in wording were made, and the appendices were brought up to date.

MISCELLANEOUS REGULATIONS

The rules and regulations governing the movement of plants and plant products into and out of the District of Columbia were revised April 29, 1931, by removing all restrictions on annual plants such as cabbage, tomato, and aster plants, except as to such regulations as may be in effect under the Japanese-beetle quarantine and other special orders, and by removing the requirement of certification at the point of origin as to herbaceous perennial plants, bulbs, and roots entering the District.

TERMINAL INSPECTION OF MAIL SHIPMENTS OF PLANTS AND PLANT PRODUCTS

The list of States, Territories, and Districts maintaining terminal inspection of mail shipments of plants and plant products under the authority of the act of March 4, 1915, remains the same as last year, namely, California, Arizona, Montana, Florida, Washington, Arkansas, the District of Columbia, Mississippi, the Territory of Hawaii, Utah, Oregon, Georgia, Idaho, Oklahoma, and Wyoming.

The terminal-inspection points in Mississippi were revised twice during the year, and those in Oregon, five times.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

The following convictions and penalties imposed for violations of the plant quarantine act were reported to the administration during the year:

European corn-borer quarantine: Eleven convictions, with fines aggregating \$760.

Fruit and vegetable quarantine: Two convictions; one defendant was fined \$45, and the other was given 49 days in jail.

Japanese-beetle quarantine: Three convictions; one defendant was fined \$200, another \$100, and the third \$25, the latter fine being remitted and the defendant placed on probation for one year.

Mediterranean fruit-fly quarantine: Sixteen convictions, with fines aggregating \$575.

Mediterranean fruit-fly and melon-fly quarantine: One conviction, with fine of \$25, which was remitted and the defendant placed on probation for one year.

Nursery stock, plant, and seed quarantine: Three convictions, with fines aggregating \$35.

Sweetpotato and yam quarantine (foreign): One conviction, with fine of \$20.

White-pine blister-rust quarantine: One conviction, with fine of \$10.

District of Columbia plant regulations: Five convictions, with fines aggregating \$420.

Quarantines affecting Mexican products: Fines aggregating \$516 were imposed by customs officials on the Mexican border against 95 persons caught attempting to smuggle in from Mexico prohibited plants and plant products. Two others were given jail sentences of 7 and 10 days, respectively.

REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PUBLIC ROADS,
Washington, D. C., September 1, 1931.

SIR: I submit herewith the report of the Bureau of Public Roads for the fiscal year ended June 30, 1931.

Respectfully,

THOMAS H. MACDONALD,
Chief of Bureau.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

Road work of all kinds in which the Federal Government has participated through the agency of the Bureau of Public Roads has been greatly increased during the fiscal year 1931 with resulting large increases in the employment of labor.

In the Federal-aid road work the roads on which improvements were completed and paid for, including those improved for the first time with Federal aid and those further improved by stage construction or reconstruction, measured 11,033 miles. The corresponding figure for the preceding year was 8,682 miles.

At the close of the year the projects under construction totaled 16,480 miles as compared with the 9,916 miles that were in progress at the end of the preceding year.

During the year Federal-aid funds to the extent of \$157,952,903 were obligated to new projects and \$133,340,910 were actually paid to the States for work done on the Federal-aid highway system. The largest previous totals corresponding to these figures were the \$102,498,084 obligated in 1930 and the \$95,749,998 paid to States in 1925.

Yet, even these unprecedented figures do not measure fully the extent of the Federal Government's monetary contribution to the States for road work during the year. To them must be added the \$76,777,000 of emergency advance funds obligated to projects and the \$20,296,266 actually paid for work done during the last six months of the year. These funds were not appropriated until December 20, 1930. Yet their virtually complete expenditure for labor performed and materials supplied is assured by August 31.

In the national-forest road work the mileage of projects completed was slightly above the record of the preceding year—281 as compared with 267 miles—and the mileage under construction at the end of the year was more than 75 per cent greater than at the close of the preceding year.

In the national parks 68 miles were completed and 328 miles were under construction, as compared with the corresponding figures of 89 and 67 miles a year ago.

EMPLOYMENT OF LABOR

By three separate actions taken during and shortly before the beginning of the last fiscal year the volume of Federal-aid road construction, normal during the previous eight years, was virtually doubled in the space of one year, and the labor employment afforded by the work correspondingly increased.

For the fiscal years 1925 to 1930, inclusive, the appropriations authorized were \$75,000,000, and during that period the rate of construction—at first somewhat higher by virtue of available balances from earlier years—had settled down to the level fixed by these annual authorizations. The movement toward an increase in the volume of work came with the authorization by Congress of an additional appropriation of \$50,000,000 for the fiscal year 1931. This authorization, made by the act approved April 4, 1930, increased the funds approved for appropriation for the year beginning July 1, 1930, from \$75,000,000, as previously authorized, to \$125,000,000, and the additional allowance, immediately apportioned, was available at once for allotment to new projects.

As stated in the last annual report, the States at once proceeded to adjust their plans to the increased rate and in the three months that remained of the fiscal year 1930 had obligated to projects \$102,498,083.84, instead of the approximate \$73,000,000 which would otherwise have been absorbed.

Allotment of the balance of funds still unobligated continued at a rapid rate into the early months of the last fiscal year, and the beginning of construction on the new projects followed just as rapidly.

The effect of the increased authorization of funds is perhaps best reflected by the mileage of road under construction from month to month. At the end of January, 1930, the mileage under construction was 8,452. By the end of February it had fallen, because of the completion of work on old projects, to 8,204 miles, and by the end of March to 8,186 miles. At each of these periods the mileage under construction was approximately 500 miles less than at the corresponding date in 1929. If this parallelism of the course of the work in the two years had continued the mileage under construction at the end of April, 1930, would have been approximately the same as at the end of March and the upturn to be expected with the opening of the new construction season would have manifested itself in a moderate increase by the end of May.

But, instead of remaining at the March level, the mileage under construction at the end of April rose by more than 500 miles to 8,716 miles, a total slightly in excess of the figure for April, 1929, and by the end of May the mileage under construction—9,431 miles—instead of being about 500 miles less than at the corresponding date in 1929, was about 500 miles greater.

This increase in the volume of active construction work, following so closely after the increase of the authorized appropriation, was the result of the anticipation of the congressional action by the States in the earlier months of 1930. In June, 1930, just two months after the increase in the authorization, the volume of work done, as indicated by Federal aid earned, exceeded by 28 per cent the greatest volume of work completed in any previous June and was greater than the average for that month in the eight preceding years by nearly 75 per cent. In only three previous months during the entire history of the Federal-aid work had the volume of work performed and the amount of Federal aid earned, exceeded the amounts for this last month of the fiscal year 1930. This was the prompt result of the increase in the authorization from \$75,000,000 to \$125,000,000 a year.

In the next two months—the first of the last fiscal year—the drought which had set in early in the year reached the proportions of a national disaster. Threatened with heavy crop losses, farmers in a number of States faced a grim prospect with the onset of winter unless in some way they could find work which would provide the means to purchase their necessities.

With the purpose of affording through Federal-aid road work the greatest possible measure of relief consistent with the limitations of existing authorized appropriations, the Secretary of Agriculture apportioned the appropriation authorized for the fiscal year 1932 on September 1, 1930. Ordinarily this apportionment would not have been made until December.

Although at the time of this action there was still unobligated about \$57,000,000 of the previously apportioned authorizations, the rate of obligation, i. e., initiation of new work, had begun to fall off rapidly and this reduction in the rate of initiation of projects could be expected in a few months hence to be reflected in the volume of active work. In June the amount obligated had been more than \$17,500,000, a sum greater by nearly 20 per cent than the greatest amount obligated in any previous June and greater than in any other month of any previous year. By August the amount obligated in the monthly period had dropped to a little over \$8,000,000, which was but little above the previous normal for the month.

This falling off in the aggregate rate of obligation with a considerable unobligated balance still on hand is explainable in two ways: (1) Available funds had been virtually exhausted in a number of States, and (2) other States which still had considerable balances unobligated were proceeding normally to absorb the money in the allotted time, believing that the new apportionment would not occur until the end of the calendar year as usual. To these there might perhaps be added one other reason already effective in a few States, namely, the virtual exhaustion of State funds with which to match the Federal apportionment.

The effect of the new apportionment was first evident in the obligations during October. September's total dropped to a little over

\$6,500,000, just about the previous normal for the month, but October's aggregate, stimulated by the new apportionment, rose to more than \$10,200,000, which was nearly twice the previous normal for the month, and although the November obligations declined to approximately \$6,800,000, they were still nearly twice the previous normal for the month and were followed by more than \$10,600,000 in December, which was nearly three times the previous December normal.

These heavy obligations in the fall of 1930 were the consequence of the early apportionment of the appropriation authorized for the fiscal year 1932. Meanwhile, favored by the extraordinarily mild and dry weather that prevailed generally, construction work was continued actively late into the fall and expenditure of the obligated funds was much greater than usual at this time of the year. Expenditures of State funds on the Federal-aid projects were, of course, correspondingly heavy and besides the Federal-aid work the States were also carrying on active work at an increased rate on independent State projects.

As a result of this uncommonly active prosecution of work and the long construction season, it became evident late in the autumn of 1930 that balances of available funds which under ordinary circumstances would have been carried over the winter to pay for work recommenced in the spring would this year be reduced in many States to negligible amounts. Since the renewal of resources depended in 43 States upon action of the legislatures, which in most cases did not convene until January 1 or later, it appeared that notwithstanding the availability of a large unobligated balance of Federal-aid funds there would be a period during the winter in which a number of States might find themselves unable to initiate new projects because of a lack of State funds with which to match the Federal aid.

At the same time it was becoming increasingly evident that there would be urgent need to provide every possible opportunity for employment to prevent actual suffering and want during the winter and early spring months.

It was to meet this situation that Congress on December 20 appropriated \$80,000,000 to be apportioned among the States in the same manner as Federal aid and used by them in lieu of an equal amount of State money to match the regular Federal-aid funds. The act appropriating the money provided for the reimbursement of the Federal Treasury by deduction of the amounts actually expended by each of the States from their respective apportionments of future Federal-aid authorizations over a period of five years, beginning with the fiscal year 1933. It also limited the amounts to be advanced to the sums actually paid out by each State for work performed before September 1, 1931.

The effect of this act was immediate. Within seven days the first projects calling for a part of the money advanced were submitted by Delaware and Maryland. By the end of January—little more than a month after the appropriation—more than \$15,000,000 had

been obligated to projects. By the end of February nearly half a million dollars had been earned by work completed. By June 30 nearly \$77,000,000 had been allotted to projects and more than half of the appropriation had been earned, the money actually paid to workers and material producers. By August 31, the limiting date, the whole amount available for use on Federal-aid roads—the sum of \$631,800 having been transferred at the request of the President to other road uses—had been allotted to projects, and although it is still too early to report exactly the amount earned, it is certain that it will come within \$1,000,000 of the total appropriated.

When the appropriation was made available a condition existed in Arkansas as the result of the previous year's drought which made it particularly desirable to start road work promptly in order to relieve distress. By June 30, six months after the appropriation of this money, every cent of the Arkansas apportionment, which was \$1,388,157, had been paid out by the State and passed into the hands of workers. But, although Arkansas was the first State to earn its entire apportionment, Iowa was the first to submit its claims in full and the first to be paid its full apportionment by the Federal Government. The last claim from this State was paid on August 7.

A full and exact report of the amounts paid to each State under this appropriation will be prepared at a later date when the final vouchers have been received from all States. A brief summarization of the operation is, however, herewith submitted in Tables 1 and 2, which, though subject to minor change, are substantially correct.

TABLE 1.—*Emergency advance fund apportionment and preliminary estimate of the amount earned to August 31, 1931*

State	Apportionment of the \$80,000,000 emergency advance fund	Preliminary estimate of the amount earned to Aug. 31, 1931	State	Apportionment of the \$80,000,000 emergency advance fund	Preliminary estimate of the amount earned to Aug. 31, 1931
Alabama.....	\$1, 698, 645	\$1, 698, 645	New Hampshire.....	\$400, 000	\$400, 000
Arizona.....	1, 170, 481	1, 169, 000	New Jersey.....	1, 107, 807	1, 107, 807
Arkansas.....	1, 388, 157	1, 388, 157	New Mexico.....	1, 303, 288	1, 303, 288
California.....	3, 108, 233	3, 108, 233	New York.....	4, 050, 566	4, 050, 566
Colorado.....	1, 507, 832	1, 507, 832	North Carolina.....	1, 926, 775	1, 926, 775
Connecticut.....	520, 491	520, 491	North Dakota.....	1, 298, 532	1, 298, 532
Delaware.....	400, 000	400, 000	Ohio.....	2, 998, 538	2, 998, 538
Florida.....	1, 086, 438	1, 086, 438	Oklahoma.....	1, 926, 351	1, 926, 351
Georgia.....	2, 077, 996	2, 077, 996	Oregon.....	1, 320, 287	1, 270, 000
Idaho.....	1, 008, 035	1, 008, 035	Pennsylvania.....	3, 512, 943	3, 512, 943
Illinois.....	3, 400, 116	3, 400, 116	Rhode Island.....	400, 000	400, 000
Indiana.....	2, 045, 929	2, 045, 929	South Carolina.....	1, 114, 636	1, 114, 636
Iowa.....	2, 116, 369	2, 116, 369	South Dakota.....	1, 337, 973	1, 337, 973
Kansas.....	2, 192, 301	2, 192, 301	Tennessee.....	1, 741, 882	1, 741, 882
Kentucky.....	1, 504, 715	1, 504, 715	Texas.....	5, 088, 080	4, 880, 218
Louisiana.....	1, 147, 927	981, 156	Utah.....	926, 521	926, 521
Maine.....	715, 799	715, 799	Vermont.....	400, 000	400, 000
Maryland.....	678, 752	678, 752	Virginia.....	1, 505, 502	1, 473, 266
Massachusetts.....	1, 141, 460	1, 141, 460	Washington.....	1, 270, 933	1, 270, 933
Michigan.....	2, 521, 382	2, 521, 382	West Virginia.....	875, 384	875, 384
Minnesota.....	2, 249, 993	2, 249, 993	Wisconsin.....	1, 992, 410	1, 992, 410
Mississippi.....	1, 434, 736	1, 434, 736	Wyoming.....	1, 029, 383	1, 029, 383
Missouri.....	2, 526, 823	2, 349, 220	Hawaii.....	400, 000	400, 000
Montana.....	1, 671, 930	1, 671, 930			
Nebraska.....	1, 708, 031	1, 708, 031			
Nevada.....	1, 049, 638	928, 000			
			Total.....	80, 000, 000	79, 242, 122

TABLE 2.—*Approximate summary of Federal-aid road operations, by months, under \$80,000,000 emergency advance appropriation*

Date	Accumulated amount obligated to projects	Estimated accumulated amount earned by completion of work	Accumulated amount paid to States	Date	Accumulated amount obligated to projects	Estimated accumulated amount earned by completion of work	Accumulated amount paid to States
1931				1931			
Jan. 31.....	\$15,366,000		-----	May 31.....	\$74,555,000	\$20,365,000	\$3,642,130.88
Feb. 28.....	37,716,000	\$486,000	-----	June 30.....	76,777,000	40,719,000	20,296,266.24
Mar. 31.....	57,728,000	2,582,000	\$36,917.04	July 31.....	79,063,000	63,266,000	35,948,781.35
Apr. 30.....	69,168,000	8,409,000	402,991.35	Aug. 31.....	79,368,000	79,242,122	53,066,701.76

As stated above, the reason for the emergency advance appropriation was the knowledge that because of the depletion of their funds a number of States could not match the Federal aid available at the end of the calendar year 1930 and that initiation of new work would be retarded for this reason. The immediate result of the appropriation was largely to increase the obligation of regular Federal-aid funds. From \$10,600,100 in December the obligations increased to \$14,500,000 in January, to nearly \$22,000,000 in February, and to more than \$27,000,000 in March. These were by far the largest monthly obligations in the history of the Federal-aid work, and they were reflected quickly in the amount of active construction work.

As a result of the high rate of completion of projects made possible by the long working season of the previous year and the momentary lag in initiation of new work because of the depletion of State funds, the mileage of Federal-aid road under construction had dropped at the end of January, 1931, to 8,812 miles, but little larger than the total at the same date in 1930. But by March 31 the mileage had risen to 10,388, virtually the figure attained by July 31 in the previous year. And at the end of the fiscal year on June 30 there were under construction 16,480 miles, exceeding by several thousand miles the largest volume of work under construction at any one time in the whole course of the Federal-aid program.

In the foregoing it has been the purpose to trace separately the separate effects of the three principal actions successively taken between April and December, 1930, to increase largely and quickly the size of the Federal-aid road construction program as a means of providing employment for idle labor.

The combined effects of all three actions were manifest in the extraordinarily large amount of construction work carried on during the first six months of the present year and the remarkably early beginning of this work. The records show that the mileage of road under construction at the end of February this year was greater than at the end of May last year, and by the end of March of the present year work was under way on a mileage of road practically equal to that which was under construction at the end of July, 1930.

Virtually complete reports of labor employed on the various classes of road work under the supervision of Federal and State agencies have been received by the bureau monthly since March by arrangement with the several State highway departments. The average number of persons employed each month on each class of work as

shown by these reports is shown in Table 3, summarized for the entire United States.

TABLE 3.—Average number of persons employed directly on various classes of road work under the supervision of Federal and State agencies, by months, from March to June, 1931, inclusive

Month	Construction of roads							Main- tenance of roads	Total
	Nation- al forest roads	Nation- al park roads	Federal-aid roads		Total Federal and Federal aid	State and State aid	Total on construc- tion		
			Regular projects	Emer- gency projects ¹					
March.....	1, 278	172	28, 068	25, 334	54, 852	58, 701	113, 553	92, 889	206, 442
April.....	2, 619	350	39, 415	55, 099	97, 483	72, 250	169, 733	90, 129	259, 862
May.....	3, 684	1, 002	39, 518	82, 387	126, 591	89, 804	216, 395	95, 050	311, 445
June.....	4, 660	2, 168	40, 223	107, 402	154, 453	101, 311	255, 764	111, 053	366, 817

¹ Under this head the figures represent the number of men employed on Federal-aid projects on which a portion of the State's share of the cost was paid with money advanced by the Federal Government under the appropriation of Dec. 20, 1930.

It will be noted that the average number of persons employed on all Federal and Federal-aid road construction, including the national-forest and park work, increased from 54,852 in March to 154,453 in June, a gain of 100,000 in the three months. In March the number given employment by the Federal and Federal-aid work was a little over a fourth of the total employed on all Federal and State work, which was 206,442. In June the Federal work employed 42 per cent of the total of 366,817 persons, the average number reported as employed on all Federal and State work. The figures given in Table 3 do not include the large numbers of laborers engaged upon road and street construction and maintenance under the administration of city, county, and township authorities, and represent only persons directly employed upon road construction and maintenance work of the Federal and State Governments.

We have estimated that for every person directly employed on the road work proper two others are employed on the average in the manufacture and transportation of road materials and equipment. The estimate has been subjected to a number of tests and appears reasonable. Assuming that it is approximately correct, the total employment furnished by the Federal and Federal-aid road work in June, 1931, was probably equivalent to the full time of more than 460,000 persons, and the Federal and State work combined probably furnished employment to over 1,000,000 persons.

We have estimated that the number of persons directly employed in June, 1930, on road work supported in whole or in part by Federal funds was approximately 64,000, or less by 90,000 than the 154,000 directly employed on work of like character in June, 1931.

PROGRESS IN FEDERAL-AID ROAD CONSTRUCTION

Initial improvements were completed during the fiscal year on 7,938.8 miles of the Federal-aid highway system; advanced stages of construction were completed on 3,082.5 miles; and 12 miles previously improved were reconstructed. The total mileage upon which im-

provements were completed was therefore 11,033.3 miles. These projects, classed as completed, were not only physically completed but had also been paid for to the full extent of its obligation by the Federal Government.

In addition to these projects, there were others on which at the end of the year all work was physically completed to the satisfaction of the bureau, and only the final payment of Federal money remained to discharge the Government's full obligation. Projects in this stage have previously been reported as completed, but, since it is not possible to report the exact cost and Federal expenditure until the final voucher has been paid, it has been deemed proper this year to report such projects separately and to indicate clearly that the total cost and Federal-aid reported are approximate.

In projects at this stage of progress there were at the end of the year 2,131.9 miles of initial construction, 881.4 miles of stage construction, and 17.5 miles of reconstruction, a total of 3,030.8 miles.

At the close of the year construction of initial improvements was in progress on 12,305.8 miles, and other initial improvements had been approved for 1,945.6 miles. Stage construction was in progress on 4,138.5 miles already initially improved with Federal aid, and similar advanced improvements had been approved of 1,033.3 miles. In addition, 35.5 miles of roads previously improved were in process of reconstruction.

The total mileage on which initial improvements had been completed and the final payment made by the Federal Government up to the beginning of the fiscal year was 90,755.2. In addition, there had been physically completed and opened to traffic 2,131.9 miles upon which some money was still due to the States for work done. Initial improvements had thus been physically completed on 92,887.1 miles included in the system on June 30. At that time, however, 4,174 miles included in the above were undergoing stage construction or reconstruction, and were, therefore, temporarily removed from the mileage available for travel, so that the bureau classifies as completed on June 30 last only 88,713.1 miles. The location of this mileage by States is shown in Table 17. Its classification by types and location is shown in Table 22.

As required by law, the progress of improvement on the entire Federal-aid highway system is each year charted on maps which are revised, as nearly as possible, annually. During the last fiscal year such maps showing the progress of construction in 46 of the 48 States were published.

Since the law requires that such maps shall show the condition of the whole system, including parts on which no Federal money has been expended, it is necessary that the bureau regularly compile information on work done independently by the States on the system as well as the work in which the Federal Government cooperates.

To present the required map record of progress it has been necessary to publish sectional maps of the United States on 108 sheets each 22 by 32 inches in size. On these sheets the location of the Federal-aid system is plotted and the various types of construction employed on each section of the system, whether by the States alone or with Federal aid, are indicated by appropriate symbols.

Official distribution is made to other Government agencies, State highway departments, map-publishing companies, recognized tour-

ing agencies, and free public libraries, aggregating over 19,000 maps. A number of the libraries have obligated themselves to provide suitable binders or containers so that the maps may be freely available and conveniently consulted.

Under arrangement with the Superintendent of Documents, separate copies for each State may be purchased at the nominal price of 10 cents per sheet.

STAGE CONSTRUCTION AND RECONSTRUCTION

As in previous years, advanced stages of improvement have been carried forward on portions of the Federal-aid system previously improved with Federal aid concurrently with the extension of initially improved mileage. Also, as in the preceding year, there has been a small amount of reconstruction of roads previously improved with Federal aid.

As explained in the last annual report, there is a clear distinction between stage construction and reconstruction. The former represents a continuation of work anticipated as eventually necessary at the time of the original improvement but deliberately deferred for one reason or another, generally because it is undesirable to expend more money upon the improvement at the moment. Reconstruction, however, becomes necessary when an improvement originally believed to be adequate is overtaken by an unanticipated increase in traffic, or simply when a surface originally adequate and perhaps still adequate for the traffic, wears out. It is now 14 years since the Federal-aid policy was inaugurated and it may be expected that henceforth there will be from year to year a certain amount of reconstruction becoming heavier as years go on. For, even with the best of maintenance, some of the earlier improvements of the less durable sort are now approaching the limit of their life.

As year follows year the ratio of stage construction to initial construction operations increases. This is clearly shown by Table 4, in which it will be seen that the stage construction has increased from a mileage equal to only 1.2 per cent of the year's initial improvements in 1923 to a mileage equal to 38.8 per cent of the initial construction in 1931.

TABLE 4.—*Mileage of initial construction, stage construction, and reconstruction completed and final payment made, by fiscal years 1923-1931, inclusive*

Fiscal year	Mileage of initial construction completed and paid for	Stage construction completed and paid for		Reconstruction completed and paid for		Mileage of total construction
		Mileage	Percentage of initial construction	Mileage	Percentage of initial construction	
1923.....	9,940.5	117.8	1.2	-----	-----	10,058.3
1924.....	9,145.6	280.7	3.1	-----	-----	9,426.3
1925.....	9,437.1	495.3	5.3	-----	-----	9,932.4
1926.....	10,533.3	783.9	7.4	-----	-----	11,317.2
1927.....	8,413.5	1,376.6	16.4	-----	-----	9,790.1
1928.....	8,532.2	2,088.8	24.5	-----	-----	10,621.0
1929.....	7,267.4	2,069.7	28.5	-----	-----	9,337.1
1930.....	6,675.4	1,988.0	29.8	18.8	0.3	8,682.2
1931.....	7,938.8	3,082.5	38.8	12.0	.2	11,033.3

This increase is the natural result of the policy that has been followed for years under which the first endeavor has been to spread a certain minimum of improvement over as large a mileage as possible and subsequently, as rapidly as funds became available or the need became acute, to further improve the roads already improved to some degree.

Under this policy many thousands of miles have been improved initially only by grading and draining, with a definite understanding expressed in the agreements with the States that surfacing and further improvement would be added in due time.

The stage-construction work does not increase the mileage of improved road but it is constantly raising the standard of improvement of the system; and it is due to the stage-construction work that although each year the initial-improvement work adds many miles of low-type improvement, the total mileage of these types is either increasing very slowly or actually decreasing. On the other hand, the mileage of high-type improvement is increasing at a more rapid rate than the initial improvements of this class would indicate.

These effects of stage construction are brought to light by a comparison of Tables 23 and 31, the first presenting the mileage of each type of highway initially completed and paid for during the last fiscal year, and the second, the net change in the mileage of each type of improvement in the portion of the system improved with Federal aid.

Thus it will be seen that although during the year there was an initial improvement of 1,854.4 miles merely by grading and draining, the mileage of road thus simply improved in the system actually shrank during the year by over 1,200 miles. And, although the year's completion of initial concrete pavements was only 3,160.3 miles, the mileage of this high type of pavement in the system increased by 4,316.5 miles.

Detailed information in regard to stage construction completed, in process, and approved will be found in Tables 18-21 and 27-30.

Information on the small mileage of reconstruction work will be found in Tables 5-11 and 18-20. In Tables 8-11, which show the old and new surface types of mileage that has been reconstructed or is now being reconstructed, and the age at the time of reconstruction, it will be seen that in every instance the new construction is of a type at least as high as the original and in nearly every instance higher.

The general age of the original surfaces at the time of reconstruction ranged from 9 to 12 years. The only surfaces below 9 years of age at the time of reconstruction were 2 of gravel—1, in Louisiana, 4 years old, and the other, in Vermont, 5 years old.

TABLE 5.—*Federal-aid projects on which reconstruction had been completed and paid for during fiscal year 1931*

State	Total cost	Federal aid	Miles	State	Total cost	Federal aid	Miles
Maine.....	\$78, 476. 74	\$23, 190. 00	1. 6	Oklahoma.....	122, 289. 26	60, 763. 24	2. 7
Massachusetts...	101, 799. 71	39, 225. 00	2. 6	Vermont.....	52, 258. 11	21, 495. 00	1. 4
New Hampshire..	241, 861. 41	55, 155. 00	3. 7	Total.....	596, 685. 23	199, 828. 24	12. 0

TABLE 6.—Federal-aid projects on which reconstruction had been completed, but final payment not made, as of June 30, 1931

State	Estimated total cost	Federal aid allotted	Miles
Maryland.....	\$587, 282. 72	\$284, 646. 88	11. 7
Oklahoma.....	160, 506. 17	62, 846. 59	5. 8
Total.....	747, 788. 89	347, 493. 47	17. 5

TABLE 7.—Federal-aid projects on which reconstruction was in progress on June 30, 1931

State	Estimated total cost	Federal aid allotted	Miles
Maryland.....	\$150, 870. 25	\$46, 100. 00	1. 8
Michigan.....	763, 792. 32	243, 375. 00	16. 1
Nevada.....	327, 117. 79	198, 652. 66	9. 2
Oklahoma.....	185, 963. 65	102, 767. 15	8. 4
Total.....	1, 427, 744. 01	590, 894. 81	35. 5

TABLE 8.—Federal-aid projects on which reconstruction had been completed on June 30, 1931, by types of construction

State	Age	Original type							
		Gravel, untreated		Bituminous macadam		Bituminous concrete		Portland cement concrete	
		New type	Miles	New type	Miles	New type	Miles	New type	Miles
Louisiana.....	Years 4	Bituminous concrete.	7.5						
Maine.....	9			Concrete..	1.6				
Do.....	7			do.....	1.9				
Maryland.....	8			do.....	6.6				
Do.....	11							Concrete..	5.9
Do.....	11			Concrete..	5.8				
Massachusetts..	8			do.....	2.7				
Do.....	10					Bituminous macadam.	2.6		
New Hampshire..	12					Concrete..	1.2		
Do.....	12					do.....	.5		
Do.....	10					do.....	2.0		
Oklahoma.....	9	Concrete..	2.6						
Do.....	9	Bridge ..	.1						
Do.....	9	Concrete..	2.5						
Do.....	9	do.....	3.3						
Vermont.....	5	do.....	1.4						

TABLE 9.—Federal-aid projects on which reconstruction had been completed and paid for during the fiscal year 1931, by types of construction

State	Age	Original type					
		Gravel, untreated		Bituminous macadam		Bituminous concrete	
		New type	Miles	New type	Miles	New type	Miles
	<i>Years</i>						
Maine.....	9			Concrete..	1.6		
Massachusetts.....	10					Bituminous macadam..	2.6
New Hampshire.....	12					Concrete.....	1.2
Do.....	12					do.....	.5
Do.....	10					do.....	2.0
Oklahoma.....	9	Concrete..	2.6				
Do.....	9	Bridge.....	.1				
Vermont.....	5	Concrete..	1.4				

TABLE 10.—Federal-aid projects on which reconstruction had been completed, but final payment not made, as of June 30, 1931, by types of construction

State	Age	Original type					
		Gravel, untreated		Bituminous macadam		Bituminous concrete	
		New type	Miles	New type	Miles	New type	Miles
	<i>Years</i>						
Maryland.....	11					Concrete.....	5.9
Do.....	11			Concrete.....	5.8		
Oklahoma.....	9	Concrete..	2.5				
Do.....	9	do.....	3.3				

TABLE 11.—Federal-aid projects on which reconstruction was in progress on June 30, 1931, by types of construction

State	Age	Original type							
		Gravel, untreated		Bituminous macadam		Bituminous concrete		Portland cement concrete	
		New type	Miles	New type	Miles	New type	Miles	New type	Miles
	<i>Years</i>								
Maryland.....	9			Concrete..	1.5				
Do.....	11			do.....	.3				
Michigan.....	8					Concrete..	10.0		
Do.....	6	Concrete..	1.3						
Do.....	6	do.....	4.8						
Nevada.....	8							Bituminous concrete.	9.2
Oklahoma.....	9	Concrete..	4.5						
Do.....	9	do.....	3.9						

CHANGES IN THE FEDERAL-AID HIGHWAY SYSTEM

In the last annual report the mileage of the Federal-aid system within the boundaries of national forests, Indian reservations, and other Federal reservations was reported as 5,456.11 miles as determined up to the close of the fiscal year 1930. During the past year further determinations have increased this mileage to 5,580.07, located, by States, as shown in Table 12.

TABLE 12.—*Mileage of Federal-aid highway system within Federal reservations, being the amounts by which the 7 per cent limiting mileage may be exceeded in each State or Territory*

State	Mileage within Federal reservations	State	Mileage within Federal reservations
Arizona.....	547.20	New Mexico.....	368.88
Arkansas.....	119.70	New York.....	16.47
California.....	457.00	North Carolina.....	176.34
Colorado.....	423.50	North Dakota.....	23.39
Georgia.....	57.80	Oklahoma.....	16.25
Idaho.....	468.40	Oregon.....	360.10
Illinois.....	4.50	Pennsylvania.....	108.21
Iowa.....	2.00	South Dakota.....	474.50
Kansas.....	14.70	Tennessee.....	66.04
Kentucky.....	6.00	Utah.....	68.90
Maine.....	4.50	Virginia.....	30.72
Michigan.....	26.50	Washington.....	353.21
Minnesota.....	74.80	West Virginia.....	29.06
Mississippi.....	10.40	Wisconsin.....	45.50
Montana.....	878.82	Wyoming.....	275.90
Nebraska.....	11.25	Hawaii.....	4.34
Nevada.....	21.77		
New Hampshire.....	33.42	Total.....	5,580.07

Under the amendment of the Federal highway act approved May 21, 1928, the original 7 per cent system in the several States may be increased by these mileages within Federal reservations, and such addition raises the permissible mileage of the initial system to 206,142 miles.

By addition to the system during the past year, made possible in part by the provisions of the amendment of May 21, 1928, the mileage of the initial system has been increased to 194,294 miles. This mileage has been further increased by extension of the system in six States in which the initial 7 per cent system has been improved to the satisfaction of the Secretary of Agriculture. The States in which such extensions have been approved are: Connecticut, in which the extension is 63.66 miles; Delaware, 341.83 miles; Maryland, 791.55 miles; New Jersey, 116.20 miles; New York, 984.10 miles; and Rhode Island, 286.06 miles. The sum of these extensions, being 2,583.40 miles, added to the initial system thus far designated, raises the mileage of the total system to 196,877 miles as of June 30, 1931, an increase of 3,827 miles in the last year.

The mileage of the designated Federal-aid system in each State, including the authorized extensions in the six States mentioned, and the mileage within Federal reservations is given in Table 17, which also shows the distribution, by States, of the 88,713.1 miles classified as completed on June 30, 1931.

The mileage classified as completed with Federal aid still includes some roads improved before 1921 and not since included in the designated Federal-aid system. These roads, if found not sufficiently important to be added to the designated system, gradually are being dropped and the Federal money invested in them transferred as a credit to the improvement of other roads in the system.

A year ago it was reported that the Federal aid originally paid for the improvement of 696 miles of such roads outside of the system had been transferred to other roads within the system. The continuation of this procedure during the past year has returned to

the Government the amount originally expended on other roads outside the system totalling 315.3 miles, and this money has been allotted to the initial or stage construction of other roads within the system.

The mileage classified as improved has also been reduced this year by reductions in the length of previously improved roads by relocations effected in stage construction, aggregating 36.2 miles.

BRIDGE CONSTRUCTION

The bridges completed as initial improvement and fully paid for during the fiscal year have with their approaches an aggregate length of 56.4 miles. Those added by stage construction completed and fully paid for aggregate 7.5 miles, making a total of 63.9 miles of bridges and their approaches completed and fully paid for during the fiscal year. In addition there were physically completed 25.2 miles of bridges as initial construction and 3 miles as stage construction, a total of 28.2 miles, on which the full share of the Federal Government has not yet been paid.

Including the structures just completed, the Federal-aid bridges completed and fully paid for by the Federal Government to date have a total length, with their approaches, of 389.7 miles.

A list of bridges completed during the year which cost \$75,000 or more is given in Table 13. These, the longest and most expensive of the projects completed, range in length from about 0.1 mile to 3.7 miles, and have an aggregate length with their approaches of 21.8 miles. The rest of the completed mileage is made up of numerous smaller and less expensive bridges, each more than 20 feet in span.

TABLE 13.—Federal-aid bridges completed during the fiscal year 1931 at a cost of \$75,000 or more each

State	Location	Stream or railroad	Estimated total cost	Length of bridge and approaches
				<i>Miles</i>
Arizona.....	{ Phoenix-Gila Bend Road near Coldwater.....	Agua Fria River.....	\$168,800	0.2
	{ Benson-Douglas Highway.....	San Pedro River.....	76,000	.1
	{ Red Bluff-California-Oregon State line.....	Cottonwood Creek.....	161,300	.2
	{ Near Cottonwood.....	Underpass Southern Pacific R. R.....	138,000	.2
California.....	{ San Lucas-Santa Maria.....	Salinas River.....	231,000	.3
	{ Victorville-Barstow.....	Mojave River.....	125,000	.1
	{ Stockton-Sacramento Road near Lodi.....	Mokelumne River.....	91,900	.2
	{ Lamar-Las Animas.....	Arkansas River.....	145,000	.2
Colorado.....	{ Grand Junction-Palisades Highway.....	Overpass Denver & Rio Grande Western R. R.....	75,600	.5
	{ Boston Post Road-Fairfield-Westport.....	Southport Cutoff-New York, New Haven & Hartford R. R.....	454,700	.6
Connecticut.....	{ Norwich-Putnam Highway.....	Quinnebaugh River.....	500,800	.5
	{ do.....	Tadpole Crossing-New York, New Haven & Hartford R. R.....	77,400	.2
Florida.....	{ Live Oak-Madison.....	Suwannee River.....	126,800	.2
	{ Tampa-Bradenton at River-view.....	Alafia River.....	103,900	.1
Indiana.....	{ Indianapolis-Jeffersonville Highway.....	Overhead Bridge Pennsylvania R. R.....	109,900	.1
Kentucky.....	{ Louisville-Bardstown.....	Salt River.....	113,600	.1
	{ Harlan-Whitesburg Highway.....	Poor Fork of Cumberland River.....	98,700	.1

TABLE 13.—Federal-aid bridges completed during the fiscal year 1931 at a cost of \$75,000 or more each—Continued

State	Location	Stream or railroad	Estimated total cost	Length of bridge and approaches
				Miles
Louisiana	Near Oberlin	Calcasieu River	\$110,800	0.3
	Tallulah-Monroe	Boeuf River	77,300	.1
	Jonesville-Harrisonburg Highway	Little River	127,300	.1
	New Orleans-Chef Menteur Highway	Chef Menteur Pass	591,700	.2
Maine	do	Rigolets Pass	1,350,000	3.7
Massachusetts	At Edgecomb	Cod Cove	118,200	1.1
Michigan	New Bedford-Wareham	Wewantic River (3 bridges)	149,900	.1
	Ann Arbor-Ypsilanti Highway	Ann Arbor R. R. and State Street	138,300	.3
Minnesota	Muskegon-Ludington	Muskegon River-Cedar Creek (3 bridges)	380,600	1.4
	Dix-Toledo Road	Underpass Detroit, Toledo & Ironton R. R.	172,900	.3
Mississippi	Champlen-Anoka	Mississippi River	398,400	.2
	Big Lake-Montrose	do	158,900	.2
Missouri	Gulfport-Pascagoula	Biloxi Bay	764,100	1.5
	Columbus-Aberdeen	Tombigbee River	91,900	.1
	South edge of Vicksburg	Overpass Yazoo & Mississippi Valley R. R.	84,300	.1
Montana	Carrollton - Keytesville Highway	Grand River	185,700	.3
	Bowling Green - Wentzville Highway	Cuivre River	104,300	.1
Nebraska	Livingstone-Laurel	Yellowstone River	78,300	.1
	Knowles-Weeksville Road	Clark Fork River	188,900	.2
	Dillon-Butte Road	Nissler Viaduct over Great Northern R. R.	78,800	.1
New Hampshire	Wolf Point-Circle Road	Little Wolf Creek	100,500	.1
	do	Missouri River	361,200	.1
New Jersey	White Way near Clarks	Platte River	85,400	.2
	Potter Place-Lebanon	Overpass Boston & Maine R. R.	98,600	.4
New Mexico	Jersey City - Newark Highway	Passaic River	682,900	.2
	Aztec-Farmington Highway	Las Animas River	105,200	.6
North Carolina	Weldon-Pleasant Hill Road	Roanoke River	225,600	.3
	Perrysburg-Maumee	Maumee River	351,100	.7
Ohio	Columbus - Lancaster Highway	Underpass Hocking Valley R. R.	107,600	.2
	Southeast of Centerburg	Underpass New York Central R. R.	117,900	.2
Oklahoma	Perkins-Coyle	Cimarron River	93,900	.2
	West of Spur	Boggy Creek	149,600	.2
Oregon	Waurika, Okla. - Ringgold, Tex.	Red River	145,200	.2
	Grants Pass	Rogue River	125,900	.1
Pennsylvania	Lemoyne-Duncannon	Sherman Creek	85,600	.1
	Bedford-McConnellsburg	Juniata River	202,800	.1
Rhode Island	Erie-Waterford	Mill Creek	144,700	.1
	Providence-East Greenwich	Overpass New York, New Haven & Hartford R. R.	132,400	.3
Texas	Hope-Anthony	Pawtuxet River	75,200	.1
	Alton-Bradford	Wood River	132,900	.2
Virginia	Houston-Beaumont Road	Trinity River	201,000	.3
	State Highway 5, Route 5	Red River & South Plains R. R.	179,800	.6
Washington	Madisonville-Crockett	Trinity River	260,100	.7
	Forney - Dallas - Kaufman County line	East Fork Trinity River	91,600	.3
West Virginia	West of Edna	Lavaca River	92,100	.2
	Jacksonville-Athens	Neches River	75,100	.2
Wisconsin	Jackson's Ferry	New River	87,800	.1
	At Glenlyn	do	104,700	.2
Wisconsin	At Prosser on Inland Empire Highway	Yakima River	84,800	.1
	At Shinnston	West Fork River	144,100	.1
	At Princeton	Fox River	83,600	.1

CONSTRUCTION OF ROADS THROUGH PUBLIC LANDS AND FEDERAL RESERVATIONS

By the act approved June 24, 1930, the Secretary of Agriculture was authorized to cooperate with State highway departments and the Department of the Interior in the survey, construction, recon-

struction, and maintenance of main roads through unappropriated or unreserved public lands, nontaxable Indian lands, or other Federal reservations other than forest reservations. The act provided that sums which might be subsequently authorized to be appropriated for this purpose should be apportioned among States having more than 5 per cent of their area in lands of the kind described and prorated to such States in the proportion that the area of such lands in each bears to the total area of the lands in all eligible States. No contribution was required of the States, and it was provided that in the allocation of such funds as might be authorized preference should be given to projects located on the Federal-aid highway system.

The emergency employment act of December 20, 1930, appropriated \$3,000,000 for this purpose. After deduction of the 2½ per cent administrative allowance the remaining sum of \$2,925,000 was apportioned as required by law among the 13 eligible States as shown in Table 14.

TABLE 14.—*Apportionment and obligation of appropriation for roads through public lands and Federal reservations*

State	Sum apportioned	Sum obligated by June 30, 1931	State	Sum apportioned	Sum obligated by June 30, 1931
Arizona.....	\$416, 328	\$416, 328. 00	Oregon.....	\$193, 377	\$173, 042. 75
California.....	230, 614		South Dakota.....	65, 715	
Colorado.....	130, 197		Utah.....	326, 683	326, 027. 47
Idaho.....	174, 316	73, 997. 99	Washington.....	55, 165	55, 165. 00
Montana.....	164, 521	66, 378. 26	Wyoming.....	280, 916	229, 881. 60
Nevada.....	588, 914	200, 933. 98			
New Mexico.....	256, 790		Total.....	2, 925, 000	1, 541, 755. 05
Oklahoma.....	41, 464				

The rules and regulations promulgated by the Secretary of Agriculture on December 29, 1930, construed the term "main roads" as used in the act of June 24, 1930, to include sections of the Federal-aid highway system, continuations thereof, and necessary connections between routes thereon, and required that projects be selected and recommended jointly by the district engineers of the Bureau of Public Roads and the interested State highway departments. The rules and regulations also permitted work to be undertaken by either the States or the Federal agency, as might be provided by project agreements entered into between the State highway departments and the Secretary of Agriculture.

By the end of the fiscal year \$1,541,755.05 of the money apportioned had been obligated to definite projects and the balance will be obligated early in the next fiscal year. The portion of each State's apportionment obligated on June 30, 1931 is shown in Table 14.

In selecting projects preference has been given, as required by law, to roads in the Federal-aid system as approved at present; and those projects which lie on roads not at present in the system are on roads of such importance that it is considered likely they will be taken into the system by future extensions.

Thus far only two projects have provided for surveys only and one has provided for surveys and the preparation of plans together with

construction. All other projects involve construction only, and no requests have been received for the use of any part of the money for maintenance purposes.

FEDERAL FUNDS APPORTIONED, OBLIGATED, AND EXPENDED

The appropriation for the fiscal year 1931 was authorized in two parts. The first part—\$75,000,000—was apportioned on December 2, 1929. The second part—\$50,000,000—authorized by the act approved April 4, 1930, was apportioned April 7, 1930. In each case the 2½ per cent allowed by law for Federal administration and research was deducted before the authorized funds were apportioned, so that the total sum apportioned was \$121,875,000 and the amounts credited to each State are as shown in Table 32.

The balance of all funds apportioned that were unobligated at the beginning of the fiscal year was \$75,716,790.80, i. e., there had been obligated to projects at the beginning of the fiscal year the equivalent of all funds apportioned for prior fiscal years and over \$46,000,000 of the funds apportioned for the fiscal year then beginning.

On September 1, 1930, the appropriation authorized for the fiscal year 1932 was apportioned. The total of this authorization was also \$125,000,000 and the amount apportioned after deduction of the administrative and research percentage was again \$121,875,000, which amount increased the total sum available for allotment to projects during the fiscal year to \$197,591,790.80.

The amount obligated during the year reached the unprecedented total of \$157,952,902.76, a sum almost twice the average amount obligated annually from 1923 to 1929 and more than \$55,000,000 greater than the amount obligated during the fiscal year 1930, which was the largest sum obligated in any year up to that time.

As a result there remained available for allotment to new projects on July 1, the first day of the fiscal year 1932, only \$39,638,888.04. Of this amount, \$2,378,280.39 consisted of unobligated 1931 funds credited to the States of Alabama, Florida, and Mississippi, and the Territory of Hawaii, and \$880,000 consisted of the sum authorized by an act approved February 23, 1931, to be paid to Hawaii from funds theretofore authorized, appropriated, allocated, and unobligated for road construction in the Territory, the sum appropriated being equal to the amount the Territory would have received for roads built and incorporated into the 7 per cent system as approved during the period from 1917 to 1925.

The remainder of the amount unobligated on July 1 consisted of funds authorized for the fiscal year 1932 in the amount of \$36,380,607.65. No other year since 1919 has opened with so small a balance of unobligated funds, notwithstanding the fact that the amount apportioned within the preceding 18 months largely exceeded the amount apportioned in any previous like period. This condition is the result of the special effort put forth during the past year by the Federal and State agencies to increase the rate of progress as greatly as possible in order to increase employment.

As stated in the report for the fiscal year 1930, the Territory of Hawaii had failed by June 30, 1930, to expend \$326,864.96 of the sum apportioned to it for the fiscal year 1928. In accordance with

the provision of law that requires that amounts unexpended of sums apportioned to any State for any year by the end of the second succeeding fiscal year shall be reapportioned among all the States, the above amount was reapportioned on August 29, 1930. The amounts apportioned to the several States are shown in Table 15.

TABLE 15.—*Reapportionment of the portion of funds apportioned to the Territory of Hawaii for the fiscal year 1928 unexpended on June 30, 1930*

State	Sum apportioned	State	Sum apportioned
Alabama.....	\$7,015.00	Nevada.....	\$4,288.00
Arizona.....	4,742.00	New Hampshire.....	1,634.00
Arkansas.....	5,832.00	New Jersey.....	4,199.00
California.....	11,214.00	New Mexico.....	5,322.00
Colorado.....	6,211.00	New York.....	16,098.00
Connecticut.....	2,125.00	North Carolina.....	7,702.00
Delaware.....	1,634.00	North Dakota.....	5,369.00
Florida.....	4,139.00	Ohio.....	12,295.00
Georgia.....	8,893.00	Oklahoma.....	7,838.00
Hawaii.....	1,634.96	Oregon.....	5,357.00
Idaho.....	4,169.00	Pennsylvania.....	14,798.00
Illinois.....	13,813.00	Rhode Island.....	1,634.00
Indiana.....	8,508.00	South Carolina.....	4,747.00
Iowa.....	8,933.00	South Dakota.....	5,509.00
Kansas.....	9,113.00	Tennessee.....	7,207.00
Kentucky.....	6,320.00	Texas.....	20,437.00
Louisiana.....	4,681.00	Utah.....	3,799.00
Maine.....	3,009.00	Vermont.....	1,634.00
Maryland.....	2,821.00	Virginia.....	6,383.00
Massachusetts.....	4,865.00	Washington.....	5,206.00
Michigan.....	9,796.00	West Virginia.....	3,553.00
Minnesota.....	9,380.00	Wisconsin.....	8,248.00
Mississippi.....	5,926.00	Wyoming.....	4,207.00
Missouri.....	10,613.00		
Montana.....	6,921.00	Total.....	326,864.96
Nebraska.....	7,093.00		

The expenditure of Federal-aid funds during the fiscal year 1930 was \$75,880,862.84. For several years the expenditure had regularly exceeded the amount authorized to be appropriated. The unexpended balances of prior appropriations had permitted this result. These had finally been virtually exhausted and the expenditure exceeded only slightly the year's apportionment of \$73,125,000.

In the report submitted last year it was pointed out that the large increase in funds obligated, as a result of the increase in the authorization to \$125,000,000, might be expected to result in a considerable increase in expenditure this year; but it was added that the annual expenditure would not reach the rate fixed by the new authorizations of \$125,000,000 for at least two years or perhaps longer.

This estimate was based upon the experience of past operations. The fact that the total expenditure this year, within 15 months of the increase in the authorization, has mounted not merely to the amount apportioned but to \$133,340,910.64, is simply another indication of the clerity with which work has been prosecuted this past year.

The largest disbursement in any previous year was nearly \$96,000,000, paid to the States in the fiscal year 1925. In no other year has the expenditure reached \$90,000,000.

A comparison of the amounts apportioned for and obligated and paid during each fiscal year from 1923 to 1931, inclusive, is presented in Table 16.

TABLE 16.—*Federal-aid funds apportioned to the States, obligated to projects and paid to the States each fiscal year from 1923 to 1931, inclusive*

Fiscal year	Apportioned amount of appropriation authorized for the year	Amount of Federal-aid funds obligated during the year	Amount of Federal-aid funds paid to States during the year
1923.....	\$48,750,000	\$77,461,559	\$69,677,241.86
1924.....	63,375,000	89,866,864	79,217,397.90
1925.....	73,125,000	87,294,396	95,749,998.11
1926.....	73,125,000	79,608,897	87,754,534.57
1927.....	73,125,000	77,453,046	81,371,013.03
1928.....	73,125,000	88,922,185	80,802,232.55
1929.....	73,125,000	70,428,896	82,097,380.38
1930.....	73,125,000	102,498,084	75,880,862.84
1931.....	121,875,000	157,952,903	133,340,910.64
Total.....	¹ 672,750,000	831,486,830	¹ 785,891,571.88
Average.....	74,750,000	92,387,425	87,321,285.76

¹ The excess of total payments over total apportionments for these years was possible because of the fact that from 1917 to 1922 inclusive the appropriations exceeded the payments by more than an equal amount.

COST OF THE ROADS

The total cost of the 7,938.8 miles of initial construction, the 3,082.5 miles of stage construction, and the 12 miles of reconstruction completed and completely paid for during the year was \$255,088,-414.09, of which the Federal Government paid \$105,918,451.14, or 41.5 per cent, and the States the balance. These expenditures were made over the period required to construct the roads, and during the same period there were additional expenditures for other projects under construction and not yet completed.

As previously stated, the total of Federal funds disbursed during the year on all active projects was \$133,340,910.64, as shown in Table 32. Of this sum, the largest amount paid in any one year, 1 State, Texas, received more than \$7,000,000; 2, Pennsylvania and Ohio, received more than \$6,000,000; 2, Illinois and Missouri, received more than \$5,000,000; 3, Georgia, Iowa, and Oklahoma, received more than \$4,000,000; and 12, Arizona, Arkansas, California, Kansas, Kentucky, Minnesota, Montana, New Mexico, New York, North Carolina, Tennessee, and Wisconsin, received more than \$3,000,000. With the exception of six States—Connecticut, Delaware, Mississippi, New Hampshire, Rhode Island, and Vermont, and the Territory of Hawaii—every State received for work done during the year in excess of \$1,000,000.

SUMMARY OF FEDERAL-AID ROAD WORK, BY STATES

The progress made in each of the States during the year and the results of the 15 years of Federal-aid road construction are reported in the following condensed summary for each State.

ALABAMA

The Federal-aid highway system includes 3,931 miles, of which 2,115.8 miles have been improved with Federal aid. Of the improved mileage, 83.9 miles were added during the year. At the close of the year 351.5 miles were under construction and 4.1 miles had been approved.

The mileage improved with Federal aid consists of 189.7 miles of graded and drained earth roads, 519.4 miles of untreated sand-clay, 900.9 miles of untreated gravel, 4.4 miles of treated gravel, 15 miles of treated macadam, 62.8 miles of bituminous macadam, 115.3 miles of bituminous concrete, and 298.2 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 10.1 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$2,768,507.17 of which the Federal share was \$1,327,018.44. The disbursement of Federal funds to the State was \$2,468,137.03. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$3,291,396.79.

ARIZONA

The Federal-aid highway system includes 1,979 miles, of which 841.9 miles have been improved with Federal aid. Of the improved mileage, 239.4 miles were added during the year. At the close of the year 489.3 miles were under construction and 7.5 miles had been approved.

The mileage improved with Federal aid consists of 27.1 miles of graded and drained earth roads, 38.3 miles of untreated sand-clay, 340.6 miles of untreated gravel, 280.8 miles of low-cost bituminous mixed surface, 0.5 mile of bituminous macadam, 37.8 miles of bituminous concrete, and 110.9 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 5.9 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 107.2 miles of stage construction, was \$3,018,902.92, of which the Federal share was \$2,209,372.79. The disbursement of Federal funds to the State was \$3,034,289.82. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$92,674.36.

ARKANSAS

The Federal-aid highway system includes 4,953 miles, of which 1,737.7 miles have been improved with Federal aid. Of the improved mileage, 120.3 miles were added during the year. At the close of the year 337.7 miles were under construction and 53.6 miles had been approved.

The mileage improved with Federal aid consists of 67.2 miles of graded and drained earth roads, 949.1 miles of untreated gravel, 41.1 miles of untreated macadam, 86.5 miles of treated macadam, 266 miles of bituminous concrete and 312.2 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 15.6 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 24.6 miles of stage construction, was \$4,143,719.74, of which the Federal share was \$1,944,640.71. The disbursement of Federal funds to the State was \$3,202,880.66. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$114,579.53.

CALIFORNIA

The Federal-aid highway system includes 4,889 miles, of which 1,928 miles have been improved with Federal aid. Of the improved mileage, 145.2 miles were added during the year. At the close of the year 396.9 miles were under construction and 60.4 miles had been approved.

The mileage improved with Federal aid consists of 397.9 miles of graded and drained earth roads, 417.8 miles of untreated gravel, 29.8 miles of untreated macadam, 133.5 miles of low-cost bituminous mixed surface, 101.2 miles of bituminous macadam, 192.9 miles of bituminous concrete, and 642.6 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 12.3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 27.7 miles of stage construction, was \$7,125,403.83, of which the Federal share was \$3,188,503.15. The disbursement of Federal funds to the State was \$3,726,979.36. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$926,385.10.

COLORADO

The Federal-aid highway system includes 3,584 miles, of which 1,343.3 miles have been improved with Federal aid. Of the improved mileage, 231.3 miles were added during the year. At the close of the year 295.2 miles were under construction and 37.3 miles had been approved.

The mileage improved with Federal aid consists of 177.5 miles of graded and drained earth roads, 55.9 miles of untreated sand-clay, 545.9 miles of untreated gravel, 95.6 miles of untreated macadam, 91.5 miles of low-cost bituminous mixed surface, 14.3 miles of bituminous concrete, and 344.4 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 18.2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 37.3 miles of stage construction, was \$4,589,021.87, of which the Federal share was \$2,404,028.79. The disbursement of Federal funds to the State was \$2,970,121.22. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,968,342.74.

CONNECTICUT

The Federal-aid highway system includes 904 miles, of which 256.9 miles have been improved with Federal aid. Of the improved mileage, 15.2 miles were added during the year. At the close of the year 49 miles were under construction and 5.5 miles had been approved.

The mileage improved with Federal aid consists of 0.2 mile of untreated gravel, 17.2 miles of untreated macadam, 0.1 mile of treated macadam, 42.7 miles of bituminous macadam, 0.6 mile of bituminous concrete, and 190.7 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 5.4 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$1,387,635.17, of which the Federal share was \$478,982.62. The disbursement of Federal funds to the State was \$826,494.20. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$4,388.65.

DELAWARE

The Federal-aid highway system includes 608 miles, of which 306 miles have been improved with Federal aid. Of the improved mileage, 55.1 miles were added during the year. At the close of the year 52.6 miles were under construction and 7.4 miles had been approved.

The mileage improved with Federal aid consists of 20.2 miles of untreated gravel, 11.7 miles of low-cost bituminous mixed surface, 5.3 miles of bituminous concrete, 262 miles of Portland cement concrete, and 6.2 miles of block pavement, in addition to which there are bridges and approaches with a total length of 0.6 mile.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$1,739,411.96, of which the Federal share was \$761,114.65. The disbursement of Federal funds to the State was \$699,494.71. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$73,516.71.

FLORIDA

The Federal-aid highway system includes 1,926 miles, of which 540 miles have been improved with Federal aid. Of the improved mileage, 36.6 miles were added during the year. At the close of the year 175.5 miles were under construction and 13.3 miles had been approved.

The mileage improved with Federal aid consists of 4.4 miles of graded and drained earth roads, 15.5 miles of untreated sand-clay, 1 mile of treated gravel, 85.4 miles of untreated macadam, 72.5 miles of treated macadam, 72.6 miles of bituminous macadam, 64.3 miles of bituminous concrete, 205.5 miles of Portland cement concrete, and 10.2 miles of block pavement, in addition to which there are bridges and approaches with a total length of 8.6 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$1,626,884.27, of which the Federal share was \$650,708.39. The disbursement of Federal funds to the State was \$1,572,336.43. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,604,812.74.

GEORGIA

The Federal-aid highway system includes 5,557 miles, of which 2,795 miles have been improved with Federal aid. Of the improved mileage, 284.7 miles were added during the year. At the close of the year 416.9 miles were under construction and 95.9 miles had been approved.

The mileage improved with Federal aid consists of 233.7 miles of graded and drained earth roads, 1,000.9 miles of untreated sand-clay,

408 miles of untreated gravel, 3.7 miles of treated gravel, 52.3 miles of untreated macadam, 129.7 miles of treated macadam, 227.5 miles of bituminous macadam, 88.2 miles of bituminous concrete, 622.7 miles of Portland cement concrete, and 0.5 mile of block pavement, in addition to which there are bridges and approaches with a total length of 27.8 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 51.6 miles of stage construction, was \$2,890,924.75, of which the Federal share was \$1,311,145.58. The disbursement of Federal funds to the State was \$4,322,392.40. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,049,771.28.

IDAHO

The Federal-aid highway system includes 3,116 miles, of which 1,281.9 miles have been improved with Federal aid. Of the improved mileage, 159.6 miles were added during the year. At the close of the year 304.1 miles were under construction and 114.2 miles had been approved.

The mileage improved with Federal aid consists of 197.8 miles of graded and drained earth roads, 604 miles of untreated gravel, 215.1 miles of untreated macadam, 101.4 miles of low-cost bituminous mixed surface, 20.3 miles of bituminous macadam, 89.7 miles of bituminous concrete, and 49.8 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 3.8 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 66.7 miles of stage construction, was \$1,564,466.12, of which the Federal share was \$899,067.70. The disbursement of Federal funds to the State was \$1,660,581.47. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$395,029.73.

ILLINOIS

The Federal-aid highway system includes 6,772 miles, of which 2,267.7 miles have been improved with Federal aid. Of the improved mileage, 281.6 miles were added during the year. At the close of the year 810.4 miles were under construction and 276.6 miles had been approved.

The mileage improved with Federal aid consists of 117 miles of graded and drained earth roads, 0.4 mile of untreated gravel, 3.3 miles of bituminous macadam, 8.1 miles of bituminous concrete, 2,104.3 miles of Portland cement concrete, and 31.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 3.7 miles of stage construction, was \$7,373,346.03, of which the Federal share was \$3,173,832.47. The disbursement of Federal funds to the State was \$5,337,535.29. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$279,005.33.

INDIANA

The Federal-aid highway system includes 4,740 miles, of which 1,579 miles have been improved with Federal aid. Of the improved mileage, 97.4 miles were added during the year. At the close of the year 281.3 miles were under construction and 129.5 miles had been approved.

The mileage improved with Federal aid consists of 16.9 miles of graded and drained earth roads, 90.2 miles of untreated gravel, 17.1 miles of bituminous macadam, 12 miles of bituminous concrete, 1,431.9 miles of Portland cement concrete, and 6.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 4.3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$6,969,639.24, of which the Federal share was \$3,206,979.94. The disbursement of Federal funds to the State was \$1,640,813.75. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$755,222.13.

IOWA

The Federal-aid highway system includes 7,214 miles, of which 3,153.1 miles have been improved with Federal aid. Of the improved mileage, 295 miles were added during the year. At the close of the year 239.4 miles were under construction and 17.4 miles had been approved.

The mileage improved with Federal aid consists of 1,104.9 miles of graded and drained earth roads, 496.7 miles of untreated gravel, 1,527.4 miles of Portland cement concrete, and 21.9 miles of block pavement, in addition to which there are bridges and approaches with a total length of 2.2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 219.7 miles of stage construction, was \$8,440,583.54, of which the Federal share was \$3,784,337.44. The disbursement of Federal funds to the State was \$4,358,844.68. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$4,059.10.

KANSAS

The Federal-aid highway system includes 7,920 miles, of which 3,148.8 miles have been improved with Federal aid. Of the improved mileage, 506.3 miles were added during the year. At the close of the year 561.4 miles were under construction and 159.2 miles had been approved.

The mileage improved with Federal aid consists of 1,066.7 miles of graded and drained earth roads, 549.8 miles of untreated sand-clay, 350.5 miles of untreated gravel, 30.3 miles of treated gravel, 4.5 miles of untreated macadam, 6.8 miles of low-cost bituminous mixed surface, 129.9 miles of bituminous macadam, 2.9 miles of bituminous concrete, 825.4 miles of Portland cement concrete, and 165.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 16.4 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 165.3 miles of stage construction, was \$7,507,055.66, of which the Federal share was \$3,543,998.02. The disbursement of Federal funds to the State was \$3,798,165.71. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$386,026.70.

KENTUCKY

The Federal-aid highway system includes 3,699 miles, of which 1,519 miles have been improved with Federal aid. Of the improved mileage, 292.8 miles were added during the year. At the close of the year 415.5 miles were under construction and 80.6 miles had been approved.

The mileage improved with Federal aid consists of 487.5 miles of graded and drained earth roads, 392.2 miles of untreated gravel, 20.5 miles of untreated macadam, 50.3 miles of treated macadam, 14.7 miles of low-cost bituminous mixed surface, 84.3 miles of bituminous macadam, 167.5 miles of bituminous concrete, 293.1 miles of Portland cement concrete, and 3.9 miles of block pavement, in addition to which there are bridges and approaches with a total length of 5 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 169.8 miles of stage construction, was \$7,403,584.13, of which the Federal share was \$3,181,640.29. The disbursement of Federal funds to the State was \$3,197,038.96. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$183,559.55.

LOUISIANA

The Federal-aid highway system includes 2,725 miles, of which 1,418.9 miles have been improved with Federal aid. Of the improved mileage, 125.5 miles were added during the year. At the close of the year 265.2 miles were under construction and 5.7 miles had been approved.

The mileage improved with Federal aid consists of 43.2 miles of graded and drained earth roads, 1,247.2 miles of untreated gravel, 3.2 miles of bituminous macadam, 42.9 miles of bituminous concrete, and 68.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 13.9 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 17.4 miles of stage construction, was \$2,497,574.06, of which the Federal share was \$1,108,436.27. The disbursement of Federal funds to the State was \$1,396,140.88. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$253,076.15.

MAINE

The Federal-aid highway system includes 1,576 miles, of which 603.2 miles have been improved with Federal aid. Of the improved mileage, 70 miles were added during the year. At the close of the

year 101 miles were under construction and 19.9 miles had been approved.

The mileage improved with Federal aid consists of 240.6 miles of untreated gravel, 56 miles of treated gravel, 181.7 miles of bituminous macadam, and 123.2 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 1.7 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 1.6 miles of reconstruction, was \$2,626,753.53, of which the Federal share was \$1,043,761.64. The disbursement of Federal funds to the State was \$1,130,502.21. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$612,261.07.

MARYLAND

The Federal-aid highway system includes 1,828 miles, of which 707 miles have been improved with Federal aid. Of the improved mileage, 86.3 miles were added during the year. At the close of the year 52.1 miles were under construction and 17.7 miles had been approved.

The mileage improved with Federal aid consists of 4.8 miles of graded and drained earth roads, 31.5 miles of untreated gravel, 0.2 mile of untreated macadam, 3.9 miles of treated macadam, 219.6 miles of bituminous macadam, 31.5 miles of bituminous concrete, and 414.9 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 0.6 mile.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 6.7 miles of stage construction, was \$2,321,767.52, of which the Federal share was \$1,080,340.41. The disbursement of Federal funds to the State was \$1,498,370.57. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$91,940.51.

MASSACHUSETTS

The Federal-aid highway system includes 1,437 miles, of which 724.2 miles have been improved with Federal aid. Of the improved mileage, 70.3 miles were added during the year. At the close of the year 78.9 miles were under construction and 17 miles had been approved.

The mileage improved with Federal aid consists of 0.5 mile of untreated gravel, 0.4 mile of treated gravel, 0.2 mile of untreated macadam, 2.7 miles of treated macadam, 19 miles of low-cost bituminous mixed surface, 408.8 miles of bituminous macadam, 66.5 miles of bituminous concrete, and 220.9 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 5.2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 0.8 mile of stage construction and 2.6 miles of reconstruction, was \$4,002,184.04, of which the Federal share was \$1,336,894.86. The disbursement of Federal funds to the State was \$1,665,230.28. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,597,158.35.

MICHIGAN

The Federal-aid highway system includes 5,242 miles, of which 1,804.8 miles have been improved with Federal aid. Of the improved mileage, 232.2 miles were added during the year. At the close of the year 338.3 miles were under construction and 109 miles had been approved.

The mileage improved with Federal aid consists of 22.4 miles of graded and drained earth roads, 343 miles of untreated gravel, 16.3 miles of treated macadam, 5.4 miles of bituminous macadam, 59 miles of bituminous concrete, 1,354.9 miles of Portland cement concrete, and 0.4 mile of block pavement, in addition to which there are bridges and approaches with a total length of 3.4 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 27.3 miles of stage construction, was \$10,460,190.17, of which the Federal share was \$4,048,668.07. The disbursement of Federal funds to the State was \$2,947,103.22. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,973,791.60.

MINNESOTA

The Federal-aid highway system includes 6,885 miles, of which 3,987.3 miles have been improved with Federal aid. Of the improved mileage, 482.2 miles were added during the year. At the close of the year 358.8 miles were under construction and 55.2 miles had been approved.

The mileage improved with Federal aid consists of 1,017.2 miles of graded and drained earth roads, 11.1 miles of untreated sand-clay, 1,846.3 miles of untreated gravel, 17.7 miles of treated gravel, 32.7 miles of bituminous concrete, and 1,059.8 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 2.5 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 240.6 miles of stage construction, was \$10,843,062.76, of which the Federal share was \$4,275,605.31. The disbursement of Federal funds to the State was \$3,669,096.61. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$27,432.47.

MISSISSIPPI

The Federal-aid highway system includes 3,661 miles, of which 1,772.7 miles have been improved with Federal aid. Of the improved mileage, 24.8 miles were added during the year. At the close of the year 262.5 miles were under construction and 20.8 miles had been approved.

The mileage improved with Federal aid consists of 284 miles of graded and drained earth roads, 15.7 miles of untreated sand-clay, 1,178.4 miles of untreated gravel, 11.1 miles of untreated macadam, 12.5 miles of bituminous concrete, 249.2 miles of Portland cement concrete, and 9.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 12.2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$1,324,571.81, of which the

Federal share was \$467,179.27. The disbursement of Federal funds to the State was \$699,603.25. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$3,759,645.69.

MISSOURI

The Federal-aid highway system includes 7,530 miles, of which 2,659.5 miles have been improved with Federal aid. Of the improved mileage, 307 miles were added during the year. At the close of the year 311.8 miles were under construction and 87 miles had been approved.

The mileage improved with Federal aid consists of 365.1 miles of graded and drained earth roads, 707.4 miles of untreated gravel, 19.6 miles of untreated macadam, 33 miles of bituminous macadam, 20 miles of bituminous concrete, 1,483.7 miles of Portland cement concrete, and 19.3 miles of block pavement, in addition to which there are bridges and approaches with a total length of 11.4 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 138.2 miles of stage construction, was \$11,764,495.20, of which the Federal share was \$4,742,406.56. The disbursement of Federal funds to the State was \$5,225,783.52. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$30,847.48.

MONTANA

The Federal-aid highway system includes 5,127 miles, of which 1,835.1 miles have been improved with Federal aid. Of the improved mileage, 272.7 miles were added during the year. At the close of the year 1,046.1 miles were under construction and 66.1 miles had been approved.

The mileage improved with Federal aid consists of 225.7 miles of graded and drained earth roads, 1,478.9 miles of untreated gravel, 72.1 miles of low-cost bituminous mixed surface, 12.5 miles of bituminous concrete, and 37 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 8.9 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 25.1 miles of stage construction, was \$3,774,599.56, of which the Federal share was \$2,278,439.12. The disbursement of Federal funds to the State was \$3,161,355.93. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$2,120,118.98.

NEBRASKA

The Federal-aid highway system includes 5,574 miles, of which 3,848.9 miles have been improved with Federal aid. Of the improved mileage, 444 miles were added during the year. At the close of the year 445.6 miles were under construction and 128.8 miles had been approved.

The mileage improved with Federal aid consists of 396.3 miles of graded and drained earth roads, 3,163.8 miles of untreated sand-

clay, 23.3 miles of treated sand-clay, 4 miles of low-cost bituminous mixed surface, 14.6 miles of bituminous concrete, 217.4 miles of Portland cement concrete, and 19.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 9.9 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 116.2 miles of stage construction, was \$2,141,382.57, of which the Federal share was \$1,012,980.95. The disbursement of Federal funds to the State was \$2,409,323.05. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$904,033.63.

NEVADA

The Federal-aid highway system includes 1,560 miles, of which 1,092 miles have been improved with Federal aid. Of the improved mileage, 169.4 miles were added during the year. At the close of the year 356.6 miles were under construction and 43.6 miles had been approved.

The mileage improved with Federal aid consists of 60.3 miles of graded and drained earth roads, 515.1 miles of untreated gravel, 10.8 miles of treated gravel, 445.3 miles of low-cost bituminous mixed surface, 20.6 miles of bituminous macadam, 2 miles of bituminous concrete, and 36 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 1.9 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 173.2 miles of stage construction, was \$1,280,385.50, of which the Federal share was \$1,117,988.62. The disbursement of Federal funds to the State was \$1,393,804.29. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$204,157.11.

NEW HAMPSHIRE

The Federal-aid highway system includes 988 miles, of which 392.9 miles have been improved with Federal aid. Of the improved mileage, 42.8 miles were added during the year. At the close of the year 27.1 miles were under construction and 10.7 miles had been approved.

The mileage improved with Federal aid consists of 0.2 mile of treated gravel, 96.5 miles of untreated macadam, 82.5 miles of treated macadam, 86.1 miles of bituminous macadam, 34.3 miles of bituminous concrete, and 88.8 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 4.5 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 3.7 miles of reconstruction, was \$1,688,554.45, of which the Federal share was \$566,971.66. The disbursement of Federal funds to the State was \$728,122.94. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$94,801.98.

NEW JERSEY

The Federal-aid highway system includes 1,315 miles, of which 555.2 miles have been improved with Federal aid. Of the improved mileage, 47.3 miles were added during the year. At the close of the year 74.7 miles were under construction and 0.2 mile had been approved.

The mileage improved with Federal aid consists of 11.9 miles of graded and drained earth roads, 6 miles of untreated gravel, 0.2 mile of treated macadam, 0.5 mile of bituminous macadam, 22.5 miles of bituminous concrete, and 511.4 miles of Portland cement concrete in addition to which there are bridges and approaches with a total length of 2.7 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$4,334,773.53, of which the Federal share was \$1,216,111.48. The disbursement of Federal funds to the State was \$1,619,943.80. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,177,568.27.

NEW MEXICO

The Federal-aid highway system includes 3,616 miles, of which 1,927.9 miles have been improved with Federal aid. Of the improved mileage, 171.5 miles were added during the year. At the close of the year 397 miles were under construction and 0.2 mile had been approved.

The mileage improved with Federal aid consists of 230.4 miles of graded and drained earth roads, 19.1 miles of untreated and sand-clay, 1,492.6 miles of untreated gravel, 96.1 miles of low-cost bituminous mixed surface, 0.7 mile of bituminous concrete, and 82.3 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6.7 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 35.7 miles of stage construction, was \$2,613,662.63, of which the Federal share was \$1,780,453.18. The disbursement of Federal funds to the State was \$3,138,928.76. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$86,785.38.

NEW YORK

The Federal-aid highway system includes 6,732 miles, of which 2,684 miles have been improved with Federal aid. Of the improved mileage, 213.5 miles were added during the year. At the close of the year 697.9 miles were under construction and 115.9 miles had been approved.

The mileage improved with Federal aid consists of 46.6 miles of graded and drained earth roads, 75.9 miles of untreated gravel, 410 miles of bituminous macadam, 15.5 miles of bituminous concrete, 2,133.3 miles of Portland cement concrete, and 0.7 mile of block pavement, in addition to which there are bridges and approaches with a total length of 2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$10,125,403.76, of which the Federal

share was \$3,157,104.88. The disbursement of Federal funds to the State was \$3,669,032.26. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$15,421.72.

NORTH CAROLINA

The Federal-aid highway system includes 4,374 miles, of which 1,970.6 miles have been improved with Federal aid. Of the improved mileage, 241.2 miles were added during the year. At the close of the year 248.5 miles were under construction and 65.4 miles had been approved.

The mileage improved with Federal aid consists of 95.5 miles of graded and drained earth roads, 470.5 miles of untreated sand-clay, 120.3 miles of untreated gravel, 25.8 miles of untreated macadam, 35.4 miles of low-cost bituminous mixed surface, 35.7 miles of bituminous macadam, 250.8 miles of bituminous concrete, and 931.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 5.1 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 28.8 miles of stage construction, was \$3,798,790.84, of which the Federal share was \$1,797,835.64. The disbursement of Federal funds to the State was \$3,366,945.86. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,608,127.62.

NORTH DAKOTA

The Federal-aid highway system includes 7,439 miles, of which 4,363.2 miles have been improved with Federal aid. Of the improved mileage, 883.7 miles were added during the year. At the close of the year 910.7 miles were under construction and 285.3 miles had been approved.

The mileage improved with Federal aid consists of 1,095.7 miles of graded and drained earth roads, 0.3 mile of untreated sand-clay, 3,116.2 miles of untreated gravel, 129.1 miles of treated gravel, 5.9 miles of low-cost bituminous mixed surface, 1.1 miles of bituminous concrete, and 6.6 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 8.3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 458.2 miles of stage construction, was \$2,551,573.01, of which the Federal share was \$1,288,488.22. The disbursement of Federal funds to the State was \$1,580,470.90. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,087,249.83.

OHIO

The Federal-aid highway system includes 5,899 miles, of which 2,553.6 miles have been improved with Federal aid. Of the improved mileage, 397.4 miles were added during the year. At the close of the year 252.7 miles were under construction and 119.3 miles had been approved.

The mileage improved with Federal aid consists of 118.9 miles of graded and drained earth roads, 34.2 miles of untreated gravel, 106.5 miles of untreated macadam, 26.1 miles of treated macadam, 368.3 miles of bituminous macadam, 159 miles of bituminous concrete, 1,124.9 miles of Portland cement concrete, and 607.4 miles of block pavement, in addition to which there are bridges and approaches with a total length of 8.3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 34.4 miles of stage construction, was \$16,809,335.96, of which the Federal share was \$6,223,666.28. The disbursement of Federal funds to the State was \$6,542,722.17. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,236,446.47.

OKLAHOMA

The Federal-aid highway system includes 5,769 miles, of which 1,981.3 miles have been improved with Federal aid. Of the improved mileage, 211.5 miles were added during the year. At the close of the year 416.1 miles were under construction and 52.9 miles had been approved.

The mileage improved with Federal aid consists of 380.6 miles of graded and drained earth roads, 0.7 mile of untreated sand-clay, 525.9 miles of untreated gravel, 8.3 miles of treated gravel, 28.7 miles of untreated macadam, 0.6 mile of bituminous macadam, 151 miles of bituminous concrete, 861.4 miles of Portland cement concrete, and 8.9 miles of block pavement, in addition to which there are bridges and approaches with a total length of 15.2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 69 miles of stage construction and 2.7 miles of reconstruction, was \$4,649,555.48, of which the Federal share was \$2,130,091.91. The disbursement of Federal funds to the State was \$4,502,041.08. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$8,011.61.

OREGON

The Federal-aid highway system includes 3,247 miles, of which 1,267.7 miles have been improved with Federal aid. Of the improved mileage, 146.5 miles were added during the year. At the close of the year 337.1 miles were under construction and 57.5 miles had been approved.

The mileage improved with Federal aid consists of 304.3 miles of graded and drained earth roads, 717 miles of untreated gravel, 13.1 miles of treated gravel, 25.6 miles of untreated macadam, 46.1 miles of bituminous macadam, 54.9 miles of bituminous concrete, and 100.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6.2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 10.6 miles of stage construction, was \$1,999,595.51, of which the Federal share was \$1,037,287.34. The disbursement of Federal funds to the State was

\$2,873,047.97. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$442,216.97.

PENNSYLVANIA

The Federal-aid highway system includes 6,335 miles, of which 2,664.4 miles have been improved with Federal aid. Of the improved mileage, 322.5 miles were added during the year. At the close of the year 251.7 miles were under construction and 96.4 miles had been approved.

The mileage improved with Federal aid consists of 166.9 miles of graded and drained earth roads, 24.4 miles of untreated macadam, 10.6 miles of treated macadam, 7.8 miles of bituminous macadam, 98.4 miles of bituminous concrete, 2,312.6 miles of Portland cement concrete, and 40.3 miles of block pavement, in addition to which there are bridges and approaches with a total length of 3.4 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 14.1 miles of stage construction, was \$30,204,188.07, of which the Federal share was \$8,248,571.56. The disbursement of Federal funds to the State was \$6,965,100.41. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date, was \$1,151,378.69.

RHODE ISLAND

The Federal-aid highway system includes 452 miles, of which 215.4 miles have been improved with Federal aid. Of the improved mileage, 30.7 miles were added during the year. At the close of the year 42.1 miles were under construction and 0.1 mile had been approved.

The mileage improved with Federal aid consists of 1.8 miles of treated macadam, 69.7 miles of bituminous macadam, 48.1 miles of bituminous concrete, and 93.7 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 2.1 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$1,847,694.03, of which the Federal share was \$723,239.22. The disbursement of Federal funds to the State was \$950,985.01. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date, was \$98,072.80.

SOUTH CAROLINA

The Federal-aid highway system includes 3,232 miles, of which 1,853.5 miles have been improved with Federal aid. Of the improved mileage, 157.4 miles were added during the year. At the close of the year 231 miles were under construction.

The mileage improved with Federal aid consists of 52.9 miles of graded and drained earth roads, 1,036.9 miles of untreated sand-clay, 101.1 miles of untreated gravel, 0.3 mile of bituminous macadam, 185 miles of bituminous concrete, and 454.4 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 22.9 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 23.5 miles of stage construction, was \$3,035,805.26, of which the Federal share was \$1,001,305.10. The disbursement of Federal funds to the State was \$2,680,153.70. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$242,641.12.

SOUTH DAKOTA

The Federal-aid highway system includes 6,193 miles, of which 3,741.6 miles have been improved with Federal aid. Of the improved mileage, 539.6 miles were added during the year. At the close of the year 607.8 miles were under construction and 62.2 miles had been approved.

The mileage improved with Federal aid consists of 117.4 miles of graded and drained earth roads, 20.8 miles of untreated sand-clay, 15.7 miles of treated sand-clay, 3,532.5 miles of untreated gravel, 9.5 miles of low-cost bituminous mixed surface, and 41.1 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 4.6 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 187.7 miles of stage construction, was \$3,726,469.50, of which the Federal share was \$1,910,950.80. The disbursement of Federal funds to the State was \$2,024,617.07. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$383,082.29.

TENNESSEE

The Federal-aid highway system includes 3,733 miles, of which 1,461.4 miles have been improved with Federal aid. Of the improved mileage, 266.5 miles were added during the year. At the close of the year 211.1 miles were under construction and 26 miles had been approved.

The mileage improved with Federal aid consists of 117 miles of graded and drained earth roads, 106.3 miles of untreated gravel, 61.5 miles of untreated macadam, 356.1 miles of bituminous macadam, 164.9 miles of bituminous concrete, and 647.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 8.1 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 61 miles of stage construction, was \$6,075,905.11, of which the Federal share was \$2,595,549.58. The disbursement of Federal funds to the State was \$3,664,142.24. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,838,996.09.

TEXAS

The Federal-aid highway system includes 11,722 miles, of which 6,979.5 miles have been improved with Federal aid. Of the improved mileage, 584.4 miles were added during the year. At the

close of the year 1,182.8 miles were under construction and 138.8 miles had been approved.

The mileage improved with Federal aid consists of 725.5 miles of graded and drained earth roads, 29.3 miles of untreated sand-clay, 2,785.4 miles of untreated gravel, 309.9 miles of treated gravel, 72.7 miles of untreated macadam, 119.7 miles of treated macadam, 19.8 miles of low-cost bituminous mixed surface, 534.8 miles of bituminous macadam, 766.1 miles of bituminous concrete, 1,550.3 miles of Portland cement concrete, and 30.2 miles of block pavement, in addition to which there are bridges and approaches with a total length of 35.8 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 261.6 miles of stage construction, was \$16,271,159.08, of which the Federal share was \$7,143,590.29. The disbursement of Federal funds to the State was \$7,366,218.34. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$3,256,872.24.

UTAH

The Federal-aid highway system includes 1,751 miles, of which 1,041.5 miles have been improved with Federal aid. Of the improved mileage, 197.1 miles were added during the year. At the close of the year 172.8 miles were under construction and 124 miles had been approved.

The mileage improved with Federal aid consists of 90.8 miles of graded and drained earth roads, 251.5 miles of untreated gravel, 3.4 miles of treated gravel, 463.3 miles of untreated macadam, 111.5 miles of low-cost bituminous mixed surface, 0.8 mile of bituminous macadam, 10.6 miles of bituminous concrete, and 106.6 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 59.8 miles of stage construction, was \$898,959.29, of which the Federal share was \$617,349.55. The disbursement of Federal funds to the State was \$1,452,586.86. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$524,243.32.

VERMONT

The Federal-aid highway system includes 1,036 miles, of which 301.6 miles have been improved with Federal aid. Of the improved mileage, 50.7 miles were added during the year. At the close of the year 35.2 miles were under construction and 2.3 miles had been approved.

The mileage improved with Federal aid consists of 102.3 miles of untreated gravel, 2 miles of treated gravel, 1.2 miles of untreated macadam, 53.4 miles of bituminous macadam, and 136.4 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6.3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 1.2 miles of stage construction

and 1.4 miles of reconstruction, was \$2,007,419.18, of which the Federal share was \$740,678.27. The disbursement of Federal funds to the State was \$750,693.40. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$52,345.06.

VIRGINIA

The Federal-aid highway system includes 3,650 miles, of which 1,624.7 miles have been improved with Federal aid. Of the improved mileage, 202.6 miles were added during the year. At the close of the year, 307.1 miles were under construction and 19 miles had been approved.

The mileage improved with Federal aid consists of 140.9 miles of graded and drained earth roads, 253.4 miles of untreated sand-clay, 95.5 miles of untreated gravel, 203 miles of untreated macadam, 5.7 miles of treated macadam, 383.1 miles of bituminous macadam, 40.6 miles of bituminous concrete, and 493.2 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 9.3 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 12 miles of stage construction, was \$4,264,542.94, of which the Federal share was \$1,897,292.76. The disbursement of Federal funds to the State was \$2,883,737.89. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$578,394.71.

WASHINGTON

The Federal-aid highway system includes 3,033 miles, of which 1,001.4 miles have been improved with Federal aid. Of the improved mileage, 93.6 miles were added during the year. At the close of the year 202.5 miles were under construction and 29.8 miles had been approved.

The mileage improved with Federal aid consists of 193.5 miles of graded and drained earth roads, 456.7 miles of untreated gravel, and 345.6 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 5.6 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 10.4 miles of stage construction, was \$3,665,180.85, of which the Federal share was \$1,522,825.01. The disbursement of Federal funds to the State was \$2,002,370.88. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$893,899.52.

WEST VIRGINIA

The Federal-aid highway system includes 2,216 miles, of which 772.6 miles have been improved with Federal aid. Of the improved mileage, 83.3 miles were added during the year. At the close of the year 142.4 miles were under construction and 22 miles had been approved.

The mileage improved with Federal aid consists of 243.1 miles of graded and drained earth roads, 30.6 miles of untreated gravel, 19.5

miles of untreated macadam, 0.6 mile of treated macadam, 181.4 miles of bituminous macadam, 28.2 miles of bituminous concrete, 256.4 miles of Portland cement concrete, and 10.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 2.2 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 45.4 miles of stage construction, was \$3,823,054.57, of which the Federal share was \$1,536,418.05. The disbursement of Federal funds to the State was \$1,039,698.29. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$334,335.98.

WISCONSIN

The Federal-aid highway system includes 5,493 miles, of which 2,414.8 miles have been improved with Federal aid. Of the improved mileage, 263.4 miles were added during the year. At the close of the year 303.4 miles were under construction and 66.5 miles had been approved.

The mileage improved with Federal aid consists of 162.3 miles of graded and drained earth roads, 23.5 miles of untreated sand-clay, 977.4 miles of untreated gravel, 19.9 miles of treated gravel, 13.7 miles of bituminous macadam, 0.5 mile of bituminous concrete, and 1,208.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 9 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 60.2 miles of stage construction, was \$8,206,234.14, of which the Federal share was \$3,628,159.37. The disbursement of Federal funds to the State was \$3,778,494.29. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$82,080.01.

WYOMING

The Federal-aid highway system includes 3,498 miles, of which 1,629 miles have been improved with Federal aid. Of the improved mileage, 182.2 miles were added during the year. At the close of the year 593.4 miles were under construction and 54.6 miles had been approved.

The mileage improved with Federal aid consists of 444.7 miles of graded and drained earth roads, 10.2 miles of untreated sand-clay, 1,013 miles of untreated gravel, 114.8 miles of low-cost bituminous mixed surface, 22.1 miles of bituminous concrete, and 17.2 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 7 miles.

The total cost of all Federal-aid roads on which final payment has been made during the year, including 89.8 miles of stage construction, was \$881,389.43, of which the Federal share was \$564,881.76. The disbursement of Federal funds to the State was \$1,450,238.37. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$162,707.71.

HAWAII

The Federal-aid highway system includes 217 miles, of which 47.6 miles have been improved with Federal aid. Of the improved mileage, 6.3 miles were added during the year. At the close of the year 41.1 miles were under construction and 1.5 miles had been approved.

The mileage improved with Federal aid consists of 1.7 miles of graded and drained earth roads, 13 miles of bituminous macadam, 13.3 miles of bituminous concrete, and 19 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 0.6 mile.

The total cost of all Federal-aid roads on which final payment has been made during the year was \$23,114.35, of which the Federal share was \$11,557.17. The disbursement of Federal funds to the State was \$298,198.65. The unobligated balance available on June 30, 1931, of all appropriations authorized and apportioned up to that date was \$1,579,975.17.

FEDERAL-AID STATISTICS

Statistical information relative to the apportionment, obligation, and disbursement of Federal aid during the fiscal year 1931, the cost of roads completed and the estimated cost of roads under construction, and the type of the roads completed and under construction, etc., is given in Tables 17 to 32, inclusive.

TABLE 17.—*Mileage of the designated Federal-aid highway system in each State and mileage improved with Federal aid to June 30, 1931*

State	Mileage of designated Federal-aid highway system	Mileage completed with Federal aid to June 30, 1931	State	Mileage of designated Federal-aid highway system	Mileage completed with Federal aid to June 30, 1931
Alabama.....	3,931	2,115.8	New Hampshire.....	988	392.9
Arizona.....	1,979	841.9	New Jersey.....	1,315	555.2
Arkansas.....	4,953	1,737.7	New Mexico.....	3,616	1,927.9
California.....	4,889	1,928.0	New York.....	6,732	2,684.0
Colorado.....	3,584	1,343.3	North Carolina.....	4,374	1,970.6
Connecticut.....	904	256.9	North Dakota.....	7,439	4,363.2
Delaware.....	608	306.0	Ohio.....	5,899	2,553.6
Florida.....	1,926	540.0	Oklahoma.....	5,769	1,981.3
Georgia.....	5,557	2,795.0	Oregon.....	3,247	1,267.7
Idaho.....	3,116	1,281.9	Pennsylvania.....	6,335	2,664.4
Illinois.....	6,772	2,267.7	Rhode Island.....	452	215.4
Indiana.....	4,740	1,579.0	South Carolina.....	3,232	1,853.5
Iowa.....	7,214	3,153.1	South Dakota.....	6,193	3,741.6
Kansas.....	7,920	3,148.8	Tennessee.....	3,733	1,461.4
Kentucky.....	3,699	1,519.0	Texas.....	11,722	6,979.5
Louisiana.....	2,725	1,418.9	Utah.....	1,751	1,041.5
Maine.....	1,576	603.2	Vermont.....	1,036	301.6
Maryland.....	1,828	707.0	Virginia.....	3,650	1,624.7
Massachusetts.....	1,437	724.2	Washington.....	3,033	1,001.4
Michigan.....	5,242	1,804.8	West Virginia.....	2,216	772.6
Minnesota.....	6,885	3,967.3	Wisconsin.....	5,493	2,414.8
Mississippi.....	3,661	1,772.7	Wyoming.....	3,498	1,629.0
Missouri.....	7,530	2,659.5	Hawaii.....	217	47.6
Montana.....	5,127	1,835.1			
Nebraska.....	5,574	3,848.9			
Nevada.....	1,560	1,092.0	Total.....	196,877	88,713.1

TABLE 18.—Total cost, Federal aid and mileage, of Federal-aid roads, initial and stage construction and reconstruction completed and paid for during the fiscal year 1931

State	Total cost	Federal aid	Mileage			
			Initial	Stage	Recon- struction	Total
Alabama.....	\$2,768,507.17	\$1,327,018.44	147.5	-----	-----	147.5
Arizona.....	3,018,902.92	2,209,372.79	128.9	107.2	-----	236.1
Arkansas.....	4,143,719.74	1,944,640.71	85.1	24.6	-----	109.7
California.....	7,125,403.83	3,188,503.15	159.9	27.7	-----	187.6
Colorado.....	4,589,021.87	2,404,028.79	195.7	37.3	-----	233.0
Connecticut.....	1,387,635.17	478,982.62	27.6	-----	-----	27.6
Delaware.....	1,739,411.96	761,114.65	61.4	-----	-----	61.4
Florida.....	1,626,884.27	650,708.39	35.8	-----	-----	35.8
Georgia.....	2,890,924.75	1,311,145.58	80.2	51.6	-----	131.8
Idaho.....	1,564,466.12	899,067.70	101.7	66.7	-----	168.4
Illinois.....	7,373,346.03	3,173,832.47	221.5	3.7	-----	225.2
Indiana.....	6,969,639.24	3,206,979.94	222.3	-----	-----	222.3
Iowa.....	8,440,583.54	3,784,337.44	93.7	219.7	-----	313.4
Kansas.....	7,507,055.66	3,543,998.02	442.4	165.3	-----	607.7
Kentucky.....	7,403,584.13	3,181,640.29	222.1	169.8	-----	391.9
Louisiana.....	2,497,574.06	1,108,436.27	100.0	17.4	-----	117.4
Maine.....	2,626,753.53	1,043,761.64	76.1	-----	1.6	77.7
Maryland.....	2,321,767.52	1,080,340.41	74.8	6.7	-----	81.5
Massachusetts.....	4,002,184.04	1,336,894.86	79.9	8	2.6	83.3
Michigan.....	10,460,190.17	4,048,668.07	217.1	27.3	-----	244.4
Minnesota.....	10,843,062.76	4,275,605.31	241.5	240.6	-----	482.1
Mississippi.....	1,324,571.81	467,179.27	30.0	-----	-----	30.0
Missouri.....	11,764,495.20	4,742,406.56	222.7	138.2	-----	360.9
Montana.....	3,774,599.56	2,278,439.12	229.2	25.1	-----	254.3
Nebraska.....	2,141,382.57	1,012,980.95	118.1	116.2	-----	234.3
Nevada.....	1,280,385.50	1,117,988.62	74.5	173.2	-----	247.7
New Hampshire.....	1,688,554.45	566,971.66	34.0	-----	3.7	37.7
New Jersey.....	4,334,773.53	1,216,111.48	58.6	-----	-----	58.6
New Mexico.....	2,613,662.63	1,780,453.18	134.8	35.7	-----	170.5
New York.....	10,125,403.76	3,157,104.88	217.5	-----	-----	217.5
North Carolina.....	3,798,790.84	1,797,835.64	194.5	28.8	-----	223.3
North Dakota.....	2,551,573.01	1,288,488.22	464.5	458.2	-----	922.7
Ohio.....	16,809,335.96	6,223,666.28	377.0	34.4	-----	411.4
Oklahoma.....	4,649,555.48	2,130,091.91	144.9	69.0	2.7	216.6
Oregon.....	1,999,595.51	1,037,287.34	150.2	10.6	-----	160.8
Pennsylvania.....	30,204,188.07	8,248,571.56	498.2	14.1	-----	512.3
Rhode Island.....	1,847,694.03	723,239.22	34.9	-----	-----	34.9
South Carolina.....	3,035,805.26	1,001,305.10	84.4	23.5	-----	107.9
South Dakota.....	3,726,469.50	1,910,950.80	335.6	187.7	-----	523.3
Tennessee.....	6,075,905.11	2,595,549.58	208.3	61.0	-----	269.3
Texas.....	16,271,159.08	7,143,590.29	531.1	261.6	-----	792.7
Utah.....	898,959.29	617,349.55	37.2	59.8	-----	97.0
Vermont.....	2,007,419.18	740,678.27	40.0	1.2	1.4	42.6
Virginia.....	4,264,542.94	1,897,292.76	199.5	12.0	-----	211.5
Washington.....	3,665,180.85	1,522,825.01	119.1	10.4	-----	129.5
West Virginia.....	3,823,054.57	1,536,418.05	70.7	45.4	-----	116.1
Wisconsin.....	8,206,234.14	3,628,159.37	257.3	60.2	-----	317.5
Wyoming.....	881,389.43	564,881.76	56.6	89.8	-----	146.4
Hawaii.....	23,114.35	11,557.17	.2	-----	-----	.2
Total.....	255,088,414.09	105,918,451.14	7,938.8	3,082.5	12.0	11,033.3

TABLE 19.—Total cost, Federal aid and mileage, of Federal-aid roads, initial and stage construction and reconstruction completed, but final payment not made, as of June 30, 1931

State	Estimated total cost	Federal aid allotted	Mileage			
			Initial	Stage	Recon- struction	Total
Alabama.....	\$1,195,281.39	\$595,171.57	29.0	26.1	-----	55.1
Arizona.....	1,183,305.96	862,350.59	40.2	42.7	-----	82.9
Arkansas.....	3,683,706.29	1,782,496.58	82.3	37.0	-----	119.3
California.....	1,335,414.23	641,815.88	34.1	1.8	-----	35.9
Colorado.....	1,029,963.21	527,588.61	30.0	6.3	-----	36.3
Connecticut.....	1,072,403.38	521,200.63	1.6	-----	-----	1.6
Florida.....	1,640,582.91	756,810.96	31.5	5.5	-----	37.0
Georgia.....	3,826,478.51	1,877,964.27	103.3	63.9	-----	167.2
Idaho.....	224,089.40	135,173.97	15.2	-----	-----	15.2
Illinois.....	2,998,506.82	1,368,817.20	81.0	25.2	-----	106.2
Indiana.....	2,195,778.21	1,064,461.20	68.9	-----	-----	68.9
Kansas.....	876,442.04	412,859.62	67.8	-----	-----	67.8
Kentucky.....	1,437,803.29	619,173.07	35.7	28.7	-----	64.4

TABLE 19.—*Total cost, Federal aid and mileage, of Federal-aid roads, initial and stage construction and reconstruction completed, but final payment not made, as of June 30, 1931—Continued*

State	Estimated total cost	Federal aid allotted	Mileage			
			Initial	Stage	Recon-struction	Total
Louisiana.....	\$2,543,880.29	\$1,298,637.03	49.3			49.3
Maine.....	242,168.53	117,632.15	7.1			7.1
Maryland.....	642,561.97	312,286.50	2.6		11.7	14.3
Massachusetts.....	2,676,897.23	702,264.97	34.4			34.4
Michigan.....	1,341,344.99	587,198.00	32.5			32.5
Minnesota.....	27,775.99					
Mississippi.....	85,915.16	42,957.57	5.4			5.4
Missouri.....	2,102,328.51	770,571.37	27.7	26.3		54.0
Montana.....	782,798.04	438,845.29	56.1	7.8		63.9
Nebraska.....	5,768,736.24	2,674,861.77	226.0	127.4		353.4
Nevada.....	370,009.47	328,753.35		44.1		44.1
New Hampshire.....	269,454.44	110,709.88	7.3			7.3
New Mexico.....	1,495,199.18	945,982.25	75.9	16.9		92.8
New York.....	4,868,931.43	1,148,325.00	75.0			75.0
North Carolina.....	1,365,426.37	667,402.24	43.5	11.0		54.5
North Dakota.....	747,024.13	373,512.00	103.6	83.6		187.2
Ohio.....	2,839,740.36	1,033,556.28	56.5	8.7		65.2
Oklahoma.....	3,028,276.50	1,466,175.42	124.4	24.5	5.8	154.7
Oregon.....	961,790.72	617,221.68	56.4	13.3		69.7
Pennsylvania.....	3,381,740.73	1,090,430.17	43.1			43.1
Rhode Island.....	479,395.02	223,002.97	6.0			6.0
South Carolina.....	3,619,240.53	1,433,961.58	43.3	90.5		133.8
South Dakota.....	556,770.15	305,711.30	61.1	17.1		78.2
Tennessee.....	1,271,410.06	563,036.51	34.8	17.6		52.4
Texas.....	4,024,400.94	1,695,824.67	140.6	71.4		212.0
Utah.....	930,521.47	646,704.16	60.0	48.9		108.9
Vermont.....	411,964.11	153,064.08	8.8			8.8
Virginia.....	1,782,837.22	851,935.15	80.2	5.2		85.4
West Virginia.....	746,011.04	247,943.30	16.2	6.7		22.9
Wisconsin.....	20,805.43	10,398.00	.3			.3
Wyoming.....	433,754.24	274,762.93	27.0	23.2		50.2
Hawaii.....	329,748.81	130,498.88	6.2			6.2
Total.....	72,848,614.94	32,430,050.60	2,131.9	881.4	17.5	3,030.8

TABLE 20.—*Total cost, Federal aid and mileage, of Federal-aid roads, initial and stage and reconstruction improvement, under construction on June 30, 1931, by States*

State	Estimated total cost	Federal aid allotted	Mileage			
			Initial	Stage	Recon-struction	Total
Alabama.....	\$7,537,014.55	\$3,671,288.23	236.7	114.8		351.5
Arizona.....	6,419,231.92	4,295,941.88	260.0	229.3		489.3
Arkansas.....	9,139,166.13	4,354,305.88	235.6	102.1		337.7
California.....	12,395,686.82	5,206,186.73	293.4	103.5		396.9
Colorado.....	5,781,305.19	3,115,215.63	206.2	89.0		295.2
Connecticut.....	4,952,563.48	1,794,286.20	49.0			49.0
Delaware.....	1,041,247.28	519,869.13	52.6			52.6
Florida.....	6,424,859.85	3,007,205.42	175.5			175.5
Georgia.....	9,004,537.69	4,302,305.86	303.1	113.8		416.9
Idaho.....	4,085,734.91	2,297,771.02	271.2	32.9		304.1
Illinois.....	25,622,263.77	11,785,892.09	769.3	41.1		810.4
Indiana.....	9,209,953.89	4,536,328.72	281.3			281.3
Iowa.....	7,336,346.86	3,144,075.10	167.3	72.1		239.4
Kansas.....	8,883,373.59	4,247,356.40	505.6	55.8		561.4
Kentucky.....	7,439,643.91	3,259,483.02	284.4	131.1		415.5
Louisiana.....	8,422,172.79	4,005,813.00	245.9	19.3		265.2
Maine.....	4,337,397.40	1,642,395.30	101.0			101.0
Maryland.....	1,652,189.40	759,448.81	47.9	2.4	1.8	52.1
Massachusetts.....	9,210,169.31	2,276,626.32	78.9			78.9
Michigan.....	10,793,690.64	4,466,907.21	314.4	7.8	16.1	338.3
Minnesota.....	7,643,473.34	3,237,288.25	74.3	284.5		358.8
Mississippi.....	4,089,403.10	2,013,896.18	182.0	80.5		262.5
Missouri.....	9,829,670.52	3,905,276.93	246.8	65.0		311.8
Montana.....	11,719,226.48	6,597,231.21	888.2	157.9		1,046.1
Nebraska.....	9,110,895.80	4,268,494.24	245.9	199.7		445.6
Nevada.....	2,946,231.13	1,983,134.43	108.0	239.4	9.2	356.6
New Hampshire.....	1,343,033.46	515,208.60	26.1	1.0		27.1
New Jersey.....	6,209,545.44	1,794,968.33	74.7			74.7
New Mexico.....	6,820,755.52	4,117,269.64	251.5	145.5		397.0
New York.....	39,415,270.33	13,701,573.50	690.9	7.0		697.9
North Carolina.....	6,565,115.87	3,126,179.57	213.1	35.4		248.5
North Dakota.....	4,377,946.70	2,233,117.38	453.3	457.4		910.7

TABLE 20.—*Total cost, Federal aid and mileage, of Federal-aid roads, initial and stage and reconstruction improvement, under construction on June 30, 1931, by States—Continued*

State	Estimate total cost	Federal aid allotted	Mileage			
			Initial	Stage	Recon-struction	Total
Ohio.....	\$15,298,336.93	\$4,780,217.25	231.1	21.6	-----	252.7
Oklahoma.....	7,764,820.32	3,678,809.67	298.4	109.3	8.4	416.1
Oregon.....	7,564,517.07	4,175,255.21	246.8	90.3	-----	337.1
Pennsylvania.....	12,715,867.36	5,194,853.56	251.7	-----	-----	251.7
Rhode Island.....	2,621,715.53	976,610.80	42.1	-----	-----	42.1
South Carolina.....	5,423,297.93	2,457,109.74	78.2	152.8	-----	231.0
South Dakota.....	6,206,502.83	3,334,679.87	419.4	188.4	-----	607.8
Tennessee.....	4,542,803.15	2,237,133.62	193.7	17.4	-----	211.1
Texas.....	20,038,372.56	9,178,199.78	858.4	324.4	-----	1,182.8
Utah.....	2,204,486.97	1,284,752.41	133.9	38.9	-----	172.8
Vermont.....	1,291,829.51	529,907.38	30.5	4.7	-----	35.2
Virginia.....	6,193,760.18	2,810,606.22	260.9	46.2	-----	307.1
Washington.....	5,833,952.87	2,590,959.02	175.7	26.8	-----	202.5
West Virginia.....	5,156,102.15	2,037,767.87	129.9	12.5	-----	142.4
Wisconsin.....	3,618,261.82	3,763,295.04	228.9	74.5	-----	303.4
Wyoming.....	4,684,178.27	2,794,003.06	351.0	242.4	-----	593.4
Hawaii.....	1,429,014.40	580,743.37	41.1	-----	-----	41.1
Total.....	387,396,991.92	172,587,244.08	12,305.8	4,138.5	35.5	16,479.8

TABLE 21.—*Total cost, Federal aid and mileage, of Federal-aid roads, initial and stage improvement, approved for construction, as of June 30, 1931, by States*

State	Estimated total cost	Federal aid allotted	Mileage		
			Initial	Stage	Total
Alabama.....	\$93,312.53	\$46,656.26	1.4	2.7	4.1
Arizona.....	84,143.72	54,813.77	2.4	5.1	7.5
Arkansas.....	1,491,745.71	713,622.89	23.7	29.9	53.6
California.....	1,804,148.84	663,854.92	60.4	-----	60.4
Colorado.....	328,975.27	184,752.46	15.9	21.4	37.3
Connecticut.....	377,652.56	176,946.82	5.5	-----	5.5
Delaware.....	180,024.00	90,012.00	7.4	-----	7.4
Florida.....	102,816.84	51,408.41	13.3	-----	13.3
Georgia.....	1,555,393.35	730,085.16	77.7	18.2	95.9
Idaho.....	987,824.36	574,435.01	58.3	55.9	114.2
Illinois.....	8,257,424.68	3,778,078.65	271.9	4.7	276.6
Indiana.....	3,030,777.18	1,453,338.00	129.5	-----	129.5
Iowa.....	549,700.61	182,458.80	-----	17.4	17.4
Kansas.....	1,804,249.75	868,140.63	113.0	46.2	159.2
Kentucky.....	880,912.21	428,092.95	60.8	19.8	80.6
Louisiana.....	120,355.82	58,515.39	5.1	.6	5.7
Maine.....	1,084,671.79	470,553.82	19.9	-----	19.9
Maryland.....	405,155.40	202,577.69	17.7	-----	17.7
Massachusetts.....	1,467,104.61	563,500.20	17.0	-----	17.0
Michigan.....	2,142,332.29	1,024,613.00	81.7	27.3	109.0
Minnesota.....	1,278,434.70	546,474.69	5.6	49.6	55.2
Mississippi.....	402,117.91	201,058.94	2.5	18.3	20.8
Missouri.....	1,979,887.13	846,926.77	61.2	25.8	87.0
Montana.....	438,573.99	243,222.95	36.9	29.2	66.1
Nebraska.....	1,653,248.55	759,179.23	54.9	68.9	123.8
Nevada.....	628,107.07	395,796.58	18.8	24.8	43.6
New Hampshire.....	465,120.12	127,744.36	3.4	7.3	10.7
New Jersey.....	144,716.24	3,420.00	.2	-----	.2
New Mexico.....	107,277.63	67,700.35	.2	-----	.2
New York.....	6,191,200.00	2,428,525.00	115.9	-----	115.9
North Carolina.....	1,023,035.04	503,233.00	29.0	36.4	65.4
North Dakota.....	877,431.89	438,715.84	90.4	194.9	285.3
Ohio.....	5,056,660.86	1,964,856.48	95.9	23.4	119.3
Oklahoma.....	1,078,316.17	579,499.44	39.0	13.9	52.9
Oregon.....	728,600.13	362,847.87	49.1	8.4	57.5
Pennsylvania.....	2,700,355.73	1,295,663.77	96.4	-----	96.4
Rhode Island.....	91,465.74	45,732.86	.1	-----	.1
South Dakota.....	512,532.94	254,606.69	15.1	47.1	62.2
Tennessee.....	380,641.70	190,320.84	26.0	-----	26.0
Texas.....	2,777,023.12	1,226,795.58	87.6	51.2	138.8
Utah.....	819,142.92	483,403.55	31.2	92.8	124.0
Vermont.....	99,416.46	25,868.93	2.3	-----	2.3
Virginia.....	497,760.77	246,236.51	18.4	.6	19.0
Washington.....	774,880.71	326,442.43	12.7	17.1	29.8
West Virginia.....	626,633.87	274,083.33	9.1	12.9	22.0
Wisconsin.....	1,690,746.84	552,719.04	48.9	17.6	66.5
Wyoming.....	311,033.86	155,516.00	10.7	43.9	54.6
Hawaii.....	82,324.99	22,869.00	1.5	-----	1.5
Total.....	60,165,458.60	26,885,946.86	1,945.6	1,033.3	2,978.9

TABLE 22.—Mileage of Federal-aid roads improved as of June 30, 1931, by types of construction, by States

State	Graded and drained		Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
	Un-treated	Treated	Un-treated	Treated	Un-treated	Treated	Un-treated	Treated							
Alabama.....	189.7	519.4	900.9	4.4	15.0	62.8	115.3	298.2	10.1	2,115.8					
Arizona.....	27.1	38.3	340.6			280.8	37.8	110.9	5.9	841.9					
Arkansas.....	67.2		949.1		86.5		266.0	312.2	15.6	1,737.7					
California.....	397.9		417.8		41.1	133.5	192.9	642.6	12.3	1,928.0					
Colorado.....	177.5	55.9	545.9		95.6	91.5	14.3	344.4	18.2	1,343.3					
Connecticut.....			2		17.2	42.7	5.3	190.7	5.4	256.9					
Delaware.....			20.2			11.7	262.0		6.2	306.0					
Florida.....	4.4	15.5		1.0	85.4	72.5	64.3	205.5	8.6	540.0					
Georgia.....	233.7	1,000.9	408.0	3.7	52.3	227.5	88.2	622.7	27.8	2,795.0					
Idaho.....	197.8		604.0		215.1	101.4	20.3	49.8	3.0	1,281.9					
Illinois.....	117.0		4				8.1		31.6	2,267.7					
Indiana.....	16.9		90.2			17.1	12.0	2,104.3	4.3	3,159.0					
Iowa.....	1,104.9		496.7	30.3	4.5	129.9	2.9		2.2	3,153.0					
Kansas.....	1,066.7	549.8	350.5		20.5	6.8	84.3	825.4	16.4	3,148.8					
Kentucky.....	487.5		392.2			14.7	167.5	293.1	5.0	1,519.0					
Louisiana.....	43.2		1,247.2		50.3	3.2	42.9	68.5	13.9	1,418.9					
Maine.....			240.6	56.0		181.7	31.5	123.2	1.7	603.2					
Maryland.....	4.8		31.5		3.9	219.6	66.5	414.9	6	707.0					
Massachusetts.....			5	4	2.7	19.0	220.9	724.2	5.2	724.2					
Michigan.....	22.4		343.0		16.3	5.4	59.0	1,354.9	3.4	1,804.8					
Minnesota.....	1,017.2	11.1	1,846.3	17.7			32.7	1,059.8	2.5	3,987.3					
Mississippi.....	284.0	15.7	1,178.4				12.5	1,772.7	12.2	1,772.7					
Missouri.....	365.1		707.4		11.1		20.0	249.2	9.6	2,659.5					
Montana.....	225.7		1,478.9		19.6	33.0	12.5	1,483.7	11.4	1,835.1					
Nebraska.....	396.3	23.3					14.6	217.4	19.6	3,848.9					
Nevada.....	60.3		515.1	10.8	82.5	20.6	2.0	36.0	9.9	992.0					
New Hampshire.....				2	96.5	86.1	34.3	88.8	4.5	392.9					
New Jersey.....	11.9					5	22.5	511.4	2.7	555.2					
New Mexico.....	230.4	19.1	6.0		2	96.1	7	82.3	6.7	1,927.9					
New York.....	46.6		1,492.6				15.5	2,133.3	2.0	2,084.0					
North Carolina.....	95.5		75.9			35.4	35.7		7	1,970.6					
North Dakota.....	1,095.7		120.3		25.8	5.9	250.8	931.5	5.1	1,970.6					
Ohio.....	118.9	3	3,116.2	129.1	26.1		1.1	6.6	8.3	4,363.2					
Oklahoma.....	380.6	7	34.2		106.5	368.3	159.0	607.4	8.3	2,553.6					
Oregon.....	304.3		525.9	8.3	28.7	46.1	151.0	861.4	15.2	1,981.3					
Pennsylvania.....	166.9		717.0	13.1	25.6	7.8	54.9	100.5	6.2	2,267.7					
Rhode Island.....					24.4	69.7	98.4	40.3	3.4	2,664.4					
South Carolina.....					1.8	45.1	454.4	93.7	2.1	215.4					
South Dakota.....					1.8	3	185.0		22.9	1,853.5					
Tennessee.....	52.9	1,036.9	101.1		61.5	9.5	164.9	41.1	4.6	3,741.6					
Texas.....	117.4	20.8	3,532.5	309.9	72.7	356.1	647.5	41.1	8.1	1,461.4					
Texas.....	725.5	29.3	2,785.4		119.7	534.8	1,550.3		35.8	6,979.5					

TABLE 23.—*Mileage of Federal-aid roads initially completed and paid for during the fiscal year 1931, by types of construction, by States*

State	Graded and drained	Sand-clay, untreated	Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
			Un-treated	Treated	Un-treated	Treated							
Utah.....	90.8		251.5	3.4	463.3		111.5	8	10.6	106.6		3.0	1,041.5
Vermont.....			102.3	2.0	1.2			53.4		136.4		6.3	301.6
Virginia.....	140.9	253.4	456.7		203.0		5.7	383.1	40.6	433.2		9.3	1,624.7
Washington.....	193.5									343.6		3.6	1,061.4
West Virginia.....	243.1	23.5	977.4	19.9	19.5		.6	181.4	23.2	256.4	10.6	2.2	772.6
Wisconsin.....	162.3		1,013.0					13.7	22.1	1,208.5		9.0	2,414.8
Wyoming.....	444.7	10.2							17.2	19.0		7.0	1,629.0
Hawaii.....	1.7							13.0	13.3			.6	47.6
Total.....	11,247.9	7,235.1	28,646.0	610.2	1,721.3	624.2	1,573.8	4,195.9	3,426.7	28,009.8	993.5	389.7	88,713.1

State	Graded and drained	Sand-clay, untreated	Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
			Un-treated	Treated	Un-treated	Treated							
Alabama.....	63.3		21.3				88.0	0.6	17.0	44.5		1.4	147.5
Arizona.....	23.8		14.9									1.6	128.9
Arkansas.....	9.6		10.1				36.7	4.4	8.1	54.7		2.6	85.1
California.....	11.7		26.0				25.4		35.2	44.2		1.7	159.9
Colorado.....	2.8		134.2						1.2	28.0		4.1	195.7
Connecticut.....							0.1	13.9		13.4		.2	27.6
Delaware.....			15.4						5.3	40.7			61.4
Florida.....	1.9					16.1			7.1	10.1		.6	35.8
Georgia.....	21.5						15.1	11.5	12.7	34.1		.4	80.2
Idaho.....	18.3		68.1								6.2	.2	101.7
Illinois.....	8.7									205.8		.8	221.5
Indiana.....										222.0		.3	222.3
Iowa.....										63.7			63.7
Kansas.....	94.8	184.6	55.3	22.5			3.8			78.3		3.1	442.4
Kentucky.....	43.5		122.6		0.1		1.8		26.4	26.6		1.1	222.1
Louisiana.....	17.6		74.4							7.2		.8	100.0
Maine.....			15.0	33.8						18.6			76.1
Maryland.....								8.7		64.5		.6	74.8
Massachusetts.....								54.2	19.2	3.5		1.0	70.9
Michigan.....	13.7		8.3							192.6		2.5	217.1
Minnesota.....	169.1		20.5							51.1		.8	241.5
Mississippi.....	28.0												30.0
Missouri.....	22.1									199.6		1.0	222.7
Montana.....	59.6		149.3				17.7			.3		2.3	229.2
Nebraska.....		116.8							.9			.4	118.1
Nevada.....			74.5										74.5
New Hampshire.....				.2		6.5				26.7		.6	34.0
New Jersey.....									.4	57.8		.2	58.6
New Mexico.....	29.4		69.2				27.0			7.9		1.3	134.8
New York.....	13.5							19.1	4.1	180.8			217.5

TABLE 23.—*Mileage of Federal-aid roads initially completed and paid for during the fiscal year 1931, by types of construction, by States—Con.*

State	Graded and drained	Sand-clay, untreated		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Un- treated	Treated	Un- treated	Treated	Un- treated	Treated							
North Carolina	21.0	41.4	28.2	3.4				35.5			67.5		0.9	194.5
North Dakota	416.0		44.5	21.4		0.1		.2		2.9	235.8	82.9	.4	464.5
Ohio	15.9								15.1				2.9	377.0
Oklahoma	77.4										66.2		1.3	144.9
Oregon	105.7		28.7						3.5		10.4		1.9	150.2
Pennsylvania	42.1					24.4					421.8	8.6	1.3	498.2
Rhode Island									22.7		11.3		.9	34.9
South Carolina	14.5	15.4	1.3							1.5	51.0		.7	84.4
South Dakota	2.7		327.2										.6	335.6
Tennessee	53.6								5.1		110.9		.5	208.3
Texas	297.8		6		12.0					43.3	196.2		7.2	531.1
Utah	6.1		25.2					5.3		17.3				37.2
Vermont			.8								36.7		.1	40.0
Virginia	65.7	29.6							1.8					199.5
Washington	38.9		60.2			67.9			28.8		6.3		1.2	110.1
West Virginia	4.4		3.3								19.3		.7	70.7
Wisconsin	18.4		67.0						14.4	5.7	42.2			257.3
Wyoming	21.3		34.8					.3			169.5		2.4	56.6
Hawaii													.2	.2
Total	1,854.4	387.8	1,522.5	71.9	22.7	92.5	22.7	256.8	208.4	207.4	3,160.3	97.7	56.4	7,938.8

TABLE 24.—*Mileage of Federal-aid roads, initial construction, completed but final payment not made, by types of construction, by States, as of June 30, 1931*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Un- treated	Treated	Un- treated	Treated	Un- treated	Treated							
Alabama											29.0			29.0
Arizona											1.7			40.2
Arkansas	3.8		22.6					15.4			46.4		0.5	82.3
California	21.0		27.0								3.7		3.1	34.1
Colorado			1.7			7.3		6.0					.4	30.0
Connecticut			23.3										.7	30.0
Florida										3.6	.3		1.3	31.5
											27.5		.4	

Georgia.....	16.0	9.7				23.6	8.7		44.6		.7	103.3
Idaho.....			15.1								.1	15.2
Illinois.....									80.9		.1	81.0
Indiana.....												68.9
Kansas.....	9.9	31.8	12.0	6.9					6.6		.6	67.8
Kentucky.....	10.5		9.1						15.9		.2	35.7
Louisiana.....			38.6						4.5		6.2	49.3
Maine.....			5.6	.4							1.1	7.1
Maryland.....									2.6			2.6
Massachusetts.....									34.4		.3	34.4
Michigan.....			13.8				18.8	2.4	12.9		.3	32.5
Mississippi.....	2.6								18.4		.3	32.5
Missouri.....	8.7								2.8			5.4
Montana.....			42.6						19.0			27.7
Nebraska.....	.2	181.0	22.5			1.3	12.9		21.1		.6	56.1
New Hampshire.....							.2	23.6	6.0		1.0	226.0
New Mexico.....	6.6		51.5								.8	7.3
New York.....		8.6	2.9						65.5			75.9
North Carolina.....	65.7		37.8						34.7			43.5
North Dakota.....			3.5				7.4		22.0		.1	103.6
Ohio.....	65.2							4.2	54.1		.8	56.5
Oklahoma.....	26.0			13.1			16.6				.7	56.4
Oregon.....	16.7								26.8		.6	43.1
Pennsylvania.....									5.7		.3	6.0
Rhode Island.....									43.0		.3	43.3
South Carolina.....			61.0								.1	61.1
South Dakota.....									7.4		.4	34.8
Tennessee.....	27.0		7.5						32.5		1.3	140.6
Texas.....	92.7		59.7				6.6				.3	60.0
Utah.....									8.7		.1	8.8
Vermont.....							29.5		12.9		.3	50.2
Virginia.....	8.3	23.9					4.4	.9	8.4			16.2
West Virginia.....							7.8					
Wisconsin.....			1						1.2		.2	27.0
Wyoming.....	5.8		12.4				7.5				.1	27.0
Hawaii.....							6.1				.1	6.2
Total.....	387.7	255.0	447.8	20.4	36.8	24.9	65.6	11.1	735.7	22.8	25.2	2,131.9

TABLE 25.—*Mileage of Federal-aid roads under initial construction on June 30, 1931, by types of construction, by States*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Un-treated	Treated	Un-treated	Treated	Un-treated	Treated							
Alabama.....	125.8			1.0				92.9			107.8		2.1	236.7
Arizona.....	32.5			131.9							45.9		2.7	260.0
Arkansas.....	172.0			15.0				160.1	10.4	38.7	25.5		3.1	235.6
California.....	23.4			27.8	2.4	2.0		88.0		9.2	206.2		4.8	206.2
Colorado.....	8.2			96.0							45.7		3.1	49.0
Connecticut.....											48.0		3	52.6
Delaware.....	4.3										175.5		5.2	175.5
Florida.....	40.4						49.6		14.9		65.4		1.4	303.1
Georgia.....	80.5	1.6		7.5			101.3		11.0		85.1		1.8	271.2
Idaho.....	49.2			176.7				43.5			687.2		6.8	763.3
Illinois.....	75.3										236.7		3.5	231.3
Indiana.....	19.1										167.3			167.3
Iowa.....											54.7		3.8	505.6
Kansas.....	373.8	36.4	3.7	12.9	8.6			11.7			74.4		1.2	284.4
Kentucky.....	148.0			50.3				10.5			138.8		2.3	245.9
Louisiana.....	18.9			85.9	52.2				11.6		36.6		.6	101.0
Maine.....									10.6	3.0	26.8		.1	47.9
Maryland.....				7.4					32.2	8.6	34.7		3.4	78.9
Massachusetts.....	89.2									12.1	179.3		1.5	314.4
Michigan.....	36.4			32.3							37.9			74.3
Minnesota.....	145.6										33.6			182.0
Mississippi.....	43.7			67.7							133.0		2.8	246.8
Missouri.....	109.9			609.2				166.6	.6		35.1		1.9	888.2
Montana.....								6.9	.7				1.8	245.9
Nebraska.....		194.4	7.0					28.5						108.0
Nevada.....				79.5							19.2		1.1	26.1
New Hampshire.....					4.0						73.5		1.2	74.7
New Jersey.....	77.5			95.6				74.9					3.5	251.5
New Mexico.....	46.1			4.0					57.7	77.9	505.0		3.2	690.9
New York.....	48.1			20.9				40.5		23.0	103.5		1.7	213.1
North Carolina.....	6.5	17.0		21.3							4.7		.5	453.3
North Dakota.....	426.5			6.1							159.8	32.9	4.9	231.1
Ohio.....	9.0			28.8	25.5		6.3		8.2	3.9	131.2		1.3	238.4
Oklahoma.....	158.5										6.8		1.6	246.8
Oregon.....	47.1							11.5	57.8		39.0	3.0	1.9	251.7
Pennsylvania.....	1.4								23.1	.8	17.8		.4	42.1
Rhode Island.....											50.6		.4	78.2
South Carolina.....		27.2											1.5	419.4
South Dakota.....	222.4			195.5							53.6		1.8	193.7
Tennessee.....	121.4										153.8		9.7	858.4
Texas.....	640.6			14.0	11.4									
Utah.....	88.7						16.5	44.6			.1		.5	133.9

TABLE 26.—*Mileage of Federal-aid roads approved for initial construction on June 30, 1931, by types of construction, by States*

State	Graded and drained	Sand-clay, untreated	Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
			Untreated	Treated	Untreated	Treated							
Vermont.....	70.9	43.5	5.6	5.4	82.6	16.1		5.3		24.5		.4	30.5
Virginia.....	73.3		1.9							12.8		1.3	260.9
Washington.....	33.9		65.4							36.4		.6	175.7
West Virginia.....	4.3		4.3			1.1		13.3	6.4	70.5		.4	129.9
Wisconsin.....	31.7		47.3							147.2		2.7	228.9
Wyoming.....	229.7		20.1				97.5	39.1		1.7		1.7	351.0
Hawaii.....	1.9											.1	41.1
Total.....	3,794.6	320.1	2,028.0	109.5	327.6	221.2	892.7	271.3	233.7	3,938.7	35.9	100.7	12,305.8
Alabama.....										1.4			1.4
Arizona.....			2.4										2.4
Arkansas.....										15.0			23.7
California.....	8.1			7.3			12.3	1.0	23.1	16.1		0.6	60.4
Colorado.....			8.3				7.5					.1	15.9
Connecticut.....										5.2		.3	5.5
Delaware.....										7.4			7.4
Florida.....	13.3												13.3
Georgia.....	28.7	6.4				12.3			18.7	11.3		.3	77.7
Idaho.....	4.5		53.6										58.3
Illinois.....	60.2									209.7		2.0	271.9
Indiana.....	4.0						30.2			94.8		.5	129.5
Iowa.....	34.5	7.7		9.0			37.3			24.3		.2	113.0
Kansas.....	49.2									11.0		.6	60.8
Kentucky.....			.4							4.7			5.1
Louisiana.....													19.9
Maine.....				14.9				1.7		2.4		.9	17.7
Maryland.....								12.2		5.5			17.0
Massachusetts.....								12.1		4.4		.5	31.7
Michigan.....	32.3									40.3		.1	81.7
Minnesota.....	5									5.1			5.6
Mississippi.....	2.4												2.5
Missouri.....	12.4		6.9					4.4		37.4		.1	61.2
Montana.....	2.0		34.8										1.1
Nebraska.....			17.5				8.0			12.6		.9	36.9
Nevada.....		33.4					1.3						54.9
New Hampshire.....										3.4			18.8
New Jersey.....										.2			3.4
New Mexico.....												.2	.2
New York.....	12.2		6.2						17.0	80.5			115.9
North Carolina.....	3.9		5.5				14.0			5.3		.3	29.0

TABLE 26.—*Mileage of Federal-aid roads approved for initial construction on June 30, 1921, by types of construction, by States—Continued*

State	Graded and drained	Sand-clay, untreated	Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
			Untreated	Treated	Untreated	Treated							
North Dakota.....	88.7		1.6							48.2		.1	90.4
Ohio.....			3.3					15.9	17.6	22.7	9.1	1.8	95.9
Oklahoma.....	16.3												39.0
Oregon.....	14.1		21.6			13.3						.1	49.1
Pennsylvania.....					82.1					14.2		.1	96.4
Rhode Island.....													.1
South Dakota.....	15.1												15.1
Tennessee.....	25.8									16.8		.2	26.0
Texas.....	68.0		20.3						9	7.5		1.9	87.6
Utah.....			.1						3.3	2.1		.1	31.2
Vermont.....					10.0							.4	18.4
Virginia.....	4.8	3.2											12.7
Washington.....			3.9							8.8			9.1
West Virginia.....													8.9
Wisconsin.....	21.0		8.1							18.2		1.6	48.9
Wyoming.....	10.7												10.7
Hawaii.....								1.5					1.5
Total.....	532.7	50.7	194.5	31.2	92.1	256.	110.6	48.8	80.6	754.4	9.1	15.3	1,945.6

TABLE 27.—*Mileage of Federal-aid-road stage construction completed and paid for during the fiscal year 1931, by types of construction, by States*

State	Graded and drained	Sand-clay, untreated	Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
			Untreated	Treated	Untreated	Treated							
Arizona.....							106.8			24.5		0.4	107.2
Arkansas.....										24.5			24.6
California.....	9.2		2.3							16.0		.1	24.6
Colorado.....			6.4				19.9			10.4		.2	27.7
Georgia.....			7.7			5.6			4.7	33.5		.6	37.3
Idaho.....			3.7				57.7			5.3		.1	51.6
Illinois.....										3.7			66.7
Iowa.....										219.7			3.7
Kansas.....	.1	66.5	53.9	1.0			3.0			40.5			219.7
Kentucky.....			59.9				2.6			72.6		.3	165.3
Louisiana.....										17.3		.2	169.8
Maryland.....	1.0									5.7		.1	17.4
Massachusetts.....													6.7
Michigan.....										27.3		.8	27.3
Minnesota.....	11.3							.1		228.1		.1	240.6
Missouri.....										138.1		.1	138.2
Montana.....							24.8					.3	25.1
Nebraska.....		81.1								35.1			116.2
Nevada.....							173.0					.2	173.2
New Mexico.....			6.3				29.4			9.6			35.7
North Carolina.....		2.9	6.9		6.2				3.1			.1	28.8
North Dakota.....			407.0	45.5			5.7			25.2	8.5	.7	34.4
Ohio.....									7.9	61.1			69.0
Oklahoma.....								4.0					10.6
Oregon.....			6.6							14.1			14.1
Pennsylvania.....										1.3			23.5
South Carolina.....									22.2	28.8			187.7
South Dakota.....	.2		158.5							60.9		.2	61.0
Tennessee.....				7.6						208.6		.4	261.6
Texas.....	19.4								17.5				59.8
Utah.....							59.5			.3			1.2
Vermont.....													1.2
Virginia.....					.8					6.4		1.1	12.0
Washington.....			10.4										10.4
West Virginia.....					15.3					30.1			48.4
Wisconsin.....										60.2			60.2
Wyoming.....	.8		41.9				46.9					.2	89.8
Total.....	42.0	150.5	771.5	54.1	22.3	5.6	529.3	20.8	90.0	1,380.4	8.5	7.5	3,082.5

TABLE 28.—*Mileage of Federal-aid roads, stage construction, completed but final payment not made, by types of construction, by States, as of June 30, 1931*

State	Graded and drained	Sand-clay, untreated	Gravel, untreated	Macadam, treated	Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Bridges and approaches	Total
Alabama							10.9	15.0	0.2	26.1
Arizona					42.5				.2	42.7
Arkansas								37.0		37.0
California	1.7								.1	1.8
Colorado					6.3					6.3
Florida				5.4					.1	5.5
Georgia				11.9			16.5	35.5		63.9
Illinois								28.2		28.2
Kentucky					10.3			18.4		28.7
Missouri								26.2	.1	26.3
Montana					7.8					7.8
Nebraska	.3	53.6						72.9	.6	127.4
Nevada					44.1					44.1
New Mexico					15.9					15.9
North Carolina	7.3		7.3				1.2	2.5	1.0	11.0
North Dakota	8.3		75.3							83.6
Ohio									.1	8.7
Oklahoma						11.3		8.6		24.5
Oregon	2.0							24.5		26.5
South Carolina							5.6	84.8	.1	90.5
South Dakota			17.1					17.6		17.1
Tennessee										
Texas								17.6		17.6
Utah			41.4					27.5	.4	71.4
Virginia	.5		.5		7.5					48.9
West Virginia						4.1			.1	3.2
Wyoming			13.7		9.5			6.7		6.7
Total	12.8	53.6	155.3	17.3	143.9	15.4	77.7	402.4	3.0	881.4

TABLE 29.—*Mileage of Federal-aid roads under stage construction on June 30, 1931, by types of construction, by States*

State	Graded and drained	Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated							
Alabama	2.9	0.5				216.3		18.5	92.7		0.2	114.8
Arizona	1.7	9.4					0.3		5		1.1	229.3
Arkansas	19.3								5			229.3
California	7.0		12.7			38.7		22.5	20.8		1.8	102.1
Colorado		.3				59.1			20.8			103.5
Georgia					34.9				76.1	2.5		89.0
Idaho	1.3	3.5				28.1					.3	113.8
Illinois									41.0			32.9
Iowa									72.1		.1	41.1
Kansas	11.6					15.6			19.3			72.1
Kentucky		26.1	8.6			22.7			61.9		.7	55.8
Louisiana	2.0							20.0			.4	131.1
Maryland									17.2			131.1
Michigan									2.4		.1	19.3
Minnesota	99.0								2.4			2.4
Mississippi	41.7								185.3		.1	7.8
Missouri	10.4								38.6		.2	284.5
Montana		60.2				97.6			54.4		.2	80.5
Nebraska											.2	65.0
Nevada		45.3				229.6			153.3		.1	157.9
New Hampshire		7.4										1.1
New Mexico	3.8	54.9				84.3			1.0			199.7
New York									1.7			239.4
North Carolina	13.2											1.0
North Dakota	62.3	294.9				93.2						145.5
Ohio							.2		10.7			7.0
Oklahoma	13.8	5.7							6.9			35.4
Oregon	11.9	5.5		1.2	3.4		61.7	6.1	19.7	.4	1.3	21.6
South Carolina									80.7			109.3
South Dakota	46.3								4			90.3
Tennessee	5.5	58.2	9.8			19.6			152.3		.5	132.8
Texas	44.2		41.8	10.7	31.4			4.0	54.2		.3	188.4
Utah	15.9	7.8				14.0		29.7	165.8			17.4
Vermont				8.8	5.7		4.7		1.1		.1	38.9
Virginia												4.7
Washington		10.7							23.5		.3	46.2
West Virginia	7.4								16.1			26.8
Wisconsin	1.4	1.2					1.8		3.3			12.5
Wyoming	1.0	57.1							71.6		.3	74.5
Total	423.6	603.4	72.9	20.7	75.4	1,103.0	68.7	119.3	1,581.2	2.9	14.2	4,138.5

TABLE 30.—Mileage of Federal-aid roads approved for stage construction on June 30, 1931, by types of construction, by States

State	Graded and drained	Sand-clay		Gravel		Macadam, treated	Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated								
Alabama.....										2.7			2.7
Arizona.....							5.1						5.1
Arkansas.....										28.9			28.9
California.....	0.7						21.3			0.3			21.4
Colorado.....						9.7							
Georgia.....										8.5			8.5
Idaho.....				2.6			53.3						53.3
Illinois.....										4.7			4.7
Iowa.....										17.4			17.4
Kansas.....	1.0	10.3		13.7	21.8					12.9			24.8
Kentucky.....							4.4			4.4			8.8
Louisiana.....													
Michigan.....										8.3			8.3
Minnesota.....	7.0					19.0				42.6			49.6
Mississippi.....	.7									17.6			18.3
Missouri.....										23.7		.1	23.8
Montana.....				11.5			17.7						17.7
Nebraska.....		46.9								21.5		.5	68.9
Nevada.....				10.6			13.6					.6	24.8
New Hampshire.....										7.3			7.3
North Carolina.....			4.0				16.2			9.9			36.4
North Dakota.....			183.3				11.6		6.0				194.9
Ohio.....				6.9				0.9		13.6	8.1		23.4
Oklahoma.....										6.8		.2	13.9
Oregon.....										1.8			1.8
South Dakota.....	11.6				27.7					7.8			47.1
Texas.....	13.2					11.1	92.3			26.6		.3	51.2
Utah.....										.5			.5
Virginia.....										6			6
Washington.....										17.1			17.1
West Virginia.....										12.9			12.9
Wisconsin.....	5.0									12.2		.4	17.6
Wyoming.....				17.9			26.0						43.9
Total.....	39.2	57.2	4.0	246.8	49.5	20.8	257.1	7.5	26.7	312.9	8.1	3.5	1,033.3

TABLE 31.—Net changes in the types of Federal-aid improvements on the Federal-aid highway system during the fiscal year 1931

State	Graded and drained		Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
	Un- treated	Treated	Un- treated	Treated	Un- treated	Treated	Un- treated	Treated							
Alabama	-70.0		-3.8		-39.2			-5.8	225.0	0.5	11.0	69.6		0.2	-38.0
Arizona	-53.1		-20.5		-121.4						-3	1.6		-2.7	31.6
Arkansas	-19.1				-80.3	-6.4	-0.4	-24.1		4.4	8.1	114.8		3.7	-3.7
California	15.4				-50.9				43.8		18.2	51.8		1.7	47.9
Colorado	-23.0		-11.2		87.2		-5.6			3.0	1.2	38.3		4.5	135.2
Connecticut												9.1		1.4	13.5
Delaware					9.0						5.3	40.7		.5	53.0
Florida	-10.5							5.5			3.6	37.5			36.6
Georgia	19.0		-128.5		-33.0			41.2		20.2	34.0	141.2		-2.4	91.7
Iaho.	17.0		21.7				-29.0		72.9		5.2			.1	87.9
Illinois	-66.9										271.5		6.2	.8	211.6
Indiana											97.1			.2	97.3
Iowa	-96.6				-24.4				6.8		294.3			.1	173.4
Kansas	-210.8				110.8	30.3			14.7		103.2		-4	2.4	314.9
Kentucky	-194.5		273.2		2.2						52.3			1.0	-11.3
Louisiana	8.1		27.4								28.7			2.4	66.6
Maine			17.8		27.7		.1			6.4		15.4		1.1	68.4
Maryland										-3.3		80.8			76.2
Massachusetts	13.8								-3.0	42.6	10.1	16.5		.6	66.8
Michigan	16.6				-232.7					-5.0	10.0	198.3		1.0	199.6
Minnesota	10.6				-42.2						2.9	266.3			51.0
Mississippi	-27.2				-45.4		-7.6		63.3	-10.0		263.6	-1.6		-47.0
Missouri	15.5				36.0				.2			127.3		2.0	172.8
Montana	-108.3		136.7		-290.0				162.8		-1.6	34.3		2.9	117.7
Nebraska	13.5					-3.5	-1.0	7.7				47.0		1.4	179.8
Nevada						.2					-9.2			-1.9	-127.3
New Hampshire									78.9			182.3		.6	40.2
New Jersey	1		-8.2		-14.3					7.5	4.0			2.6	23.5
New Mexico	-35.3								35.4	.1	-6.1				153.0
New York	7.6		-4.1		42.3		6.2		5.9			107.5		1.1	190.0
North Carolina	-280.1		-10.5		336.4	48.5									100.6
North Dakota	-1.7				24.8										363.2
Ohio	2.1				-33.3		-4.2								117.3
Oklahoma	69.0				5.5	13.1				11.8	2.9	241.1	84.7	3.8	90.9
Oregon	10.0											120.3		1.8	363.2
Pennsylvania										31.9	-9.3	5.8		1.3	117.3
Rhode Island										12.6		285.8	.8	1.4	322.5
South Carolina	9.6		-165.1		-6.6		24.4			-2.8	-1.0	16.9		1.2	30.7
South Dakota	-87.1		-15.2		369.9							150.7		.7	-15.0
Tennessee	12.3									-5.6	43.3	28.2		.9	206.5
Texas	-109.8		-10.1		-72.2	17.7				13.0	56.5	243.2		5.6	143.9

TABLE 31.—*Net changes in the types of Federal-aid improvements on the Federal-aid highway system during the fiscal year 1931—Cont.*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low cost bituminous mix	Bituminous macadam	Bituminous concrete	Port-land cement concrete	Block	Bridges and approaches	Total
		Un-treated	Treated	Un-treated	Treated	Un-treated	Treated							
Utah	-20.1			104.7		-97.6		72.3			7			60.3
Vermont				-4.3					1.8		46.8		.3	46.0
Virginia	55.9			-5.8					9.0		-8.9		1.7	46.0
Washington	14.1	37.1		36.3		69.2	-3.7			.8			3.2	156.8
West Virginia	-6.5			2.3							15.8		.6	66.8
Wisconsin	18.1	-3		-52.8		5.3			-3.6	-5	66.2		.1	62.5
Wyoming	-86.9	-4		-47.2				52.9		.1	201.4		2.1	168.6
Hawaii									6.1		1.3		.6	-79.7
Total	-1,200.7	69.1	22.5	38.1	127.6	-32.9	20.8	831.9	138.7	222.0	4,316.5	88.9	57.8	4,700.3

TABLE 32.—*Federal-aid apportionment, and amounts paid to the States for the fiscal year 1931, and the unobligated balance of the total apportionment on June 30, 1931*

State	Apportionment fiscal year 1931	Paid to States during the fiscal year 1931	Unobligated balances of total apportionment on June 30, 1931
Alabama.....	\$2,595,620	\$2,468,137.03	\$3,291,396.79
Arizona.....	1,770,317	3,034,289.82	92,674.36
Arkansas.....	2,155,143	3,202,880.66	114,579.53
California.....	4,168,617	3,726,979.36	926,385.10
Colorado.....	2,317,540	2,970,121.22	1,968,342.74
Connecticut.....	796,489	826,494.20	4,388.65
Delaware.....	609,375	699,494.71	73,516.71
Florida.....	1,535,930	1,572,336.43	1,604,812.74
Georgia.....	3,309,387	4,322,392.40	1,049,771.28
Idaho.....	1,554,323	1,660,581.47	395,029.73
Illinois.....	5,167,968	5,337,535.29	279,005.33
Indiana.....	3,182,508	1,640,813.75	755,222.13
Iowa.....	3,343,240	4,358,844.68	4,059.10
Kansas.....	3,414,308	3,798,165.71	386,026.70
Kentucky.....	2,357,683	3,197,038.96	183,559.55
Louisiana.....	1,733,658	1,396,140.88	253,076.15
Maine.....	1,125,177	1,130,502.21	612,261.07
Maryland.....	1,053,185	1,498,370.57	91,940.51
Massachusetts.....	1,816,704	1,665,230.28	1,597,158.35
Michigan.....	3,666,962	2,947,103.22	1,973,791.60
Minnesota.....	3,504,977	3,669,096.61	27,432.47
Mississippi.....	2,206,495	699,603.25	3,759,645.69
Missouri.....	3,970,638	5,225,783.52	30,847.48
Montana.....	2,588,108	3,161,355.93	2,120,118.98
Nebraska.....	2,644,210	2,409,323.05	904,033.63
Nevada.....	1,601,408	1,393,804.29	204,157.11
New Hampshire.....	609,375	728,122.94	94,801.98
New Jersey.....	1,560,390	1,619,943.80	1,177,568.27
New Mexico.....	1,983,827	3,138,928.76	86,785.38
New York.....	6,009,941	3,669,032.26	15,421.72
North Carolina.....	2,871,122	3,366,945.86	1,608,127.62
North Dakota.....	2,005,100	1,580,470.90	1,087,249.83
Ohio.....	4,589,213	6,542,722.17	1,236,446.47
Oklahoma.....	2,918,358	4,502,041.08	8,011.61
Oregon.....	1,996,112	2,873,047.97	442,216.97
Pennsylvania.....	5,524,512	6,965,100.41	1,151,378.69
Rhode Island.....	609,375	950,985.01	98,072.80
South Carolina.....	1,775,175	2,680,153.70	242,641.12
South Dakota.....	2,054,937	2,024,617.07	383,082.29
Tennessee.....	2,681,337	3,664,142.24	1,838,996.09
Texas.....	7,576,384	7,366,218.34	3,256,872.24
Utah.....	1,417,920	1,452,586.86	524,243.32
Vermont.....	609,375	750,693.40	52,345.06
Virginia.....	2,382,088	2,883,737.89	578,394.71
Washington.....	1,927,031	2,002,370.88	893,899.52
West Virginia.....	1,321,376	1,039,698.29	334,335.98
Wisconsin.....	3,081,949	3,778,494.29	82,080.01
Wyoming.....	1,570,758	1,450,238.37	162,707.71
Hawaii.....	609,375	298,198.65	1,579,975.17
Total.....	121,875,000	133,340,910.64	39,638,888.04

NATIONAL-FOREST ROAD CONSTRUCTION

During the past year improvements have been completed on 280.9 miles of the forest-road system, bringing the total mileage improved to date with Federal funds to 4,638.4 miles. Of the mileage improved during the year, 254.9 miles were in the Western States and Alaska and the remaining 26 miles were in the forests of six Eastern States. Of the total mileage improved to date, 4,281.6 miles are in the West and 356.8 in the East.

The mileage of forest-highway projects completed during the year and to date by States is shown in Table 33.

TABLE 33.—*Mileage of completed forest-highway projects, by States*

State	Mileage of forest-highway projects completed		State	Mileage of forest-highway projects completed	
	During 1931	Total to June 30, 1931		During 1931	Total to June 30, 1931
Western:			Eastern:		
Alaska.....	8.9	230.9	Alabama.....		5.1
Arizona.....	22.5	358.7	Arkansas.....	9.7	74.9
California.....	53.7	437.4	Florida.....	1.0	65.2
Colorado.....	20.1	365.8	Georgia.....		21.4
Idaho.....	34.5	542.9	Michigan.....	0.8	8.9
Montana.....	17.8	409.5	Minnesota.....	8.2	68.8
Nevada.....	12.3	126.8	New Hampshire.....		5.2
New Mexico.....	8.4	198.8	North Carolina.....		36.3
Oregon.....	28.3	705.8	South Carolina.....		16.0
South Dakota.....		46.2	Tennessee.....	3.9	37.4
Utah.....	32.6	340.5	Virginia.....	2.4	17.6
Washington.....	6.2	233.9			
Wyoming.....	9.6	284.4	Total.....	26.0	356.8
Total.....	254.9	4,281.6	Grand total.....	280.9	4,638.4

In the forest-highway system as approved to date there are 15,024.1 miles, of which 12,538.5 miles are in the Western States and Alaska and 2,485.6 miles are in the Eastern States and Porto Rico. Class 1 highways, which are necessary sections or extensions of the Federal-aid highway system lying wholly within the forest areas, total 1,384.6 miles, of which 923.1 miles are in the Western States. Class 2 highways, which also extend the Federal-aid system, total 7,402.5 miles, of which 7,074.1 miles are in the West. The class 3 highways, those that serve communities within the forests, total 6,237 miles, of which 4,541.3 miles are in the Western States.

The mileage of each of the three classes of highways and the total mileage of the forest-highway system in each State are shown in Table 34.

TABLE 34.—*Classified mileage of forest-highway system, by States*

State	Mileage of forest-highway system			
	Class 1	Class 2	Class 3	Total
Western:				
Alaska.....			443.9	443.9
Arizona.....	263.3	491.0	265.0	1,019.3
California.....	320.5	985.0	976.0	2,281.5
Colorado.....		1,240.0	483.0	1,723.0
Idaho.....	4.0	792.7	247.5	1,044.2
Montana.....	147.4	687.5	363.0	1,197.9
Nevada.....		373.8	95.4	469.2
New Mexico.....	115.0	219.0	226.5	560.5
Oregon.....	66.2	782.4	591.2	1,439.8
South Dakota.....	2.0	217.0	86.0	305.0
Utah.....		457.9	290.2	748.1
Washington.....	4.7	472.8	321.6	799.1
Wyoming.....		355.0	152.0	507.0
Total.....	923.1	7,074.1	4,541.3	12,538.5

TABLE 34.—*Classified mileage of forest-highway system, by States—Continued*

State	Mileage of forest-highway system			
	Class 1	Class 2	Class 3	Class 4
Eastern:				
Alabama.....			41.0	41.0
Arkansas.....	169.8	34.0	14.0	217.8
Florida.....		0.7	106.0	106.7
Georgia.....	31.6	10.2	85.5	127.3
Maine.....			11.0	11.0
Michigan.....	49.9		272.5	322.4
Minnesota.....	41.0	38.5	166.0	245.5
Nebraska.....			28.8	28.8
New Hampshire.....	30.0	50.0	49.0	129.0
North Carolina.....	78.7	50.0	108.9	237.6
Oklahoma.....			40.0	40.0
Pennsylvania.....	24.5	16.0	157.0	197.5
Porto Rico.....			9.0	9.0
South Carolina.....		6.0	40.0	46.0
Tennessee.....	36.0	81.0	167.0	284.0
Virginia.....		38.0	269.0	307.0
West Virginia.....		4.0	131.0	135.0
Total.....	461.5	328.4	1,695.7	2,485.6
Grand total.....	1,384.6	7,402.5	6,237.0	15,024.1

For several years prior to the past year the annual authorization for forest roads and trails had been \$7,500,000, of which \$4,500,000 was reserved for the more important roads designated as forest highways. For this year the total appropriation authorized was \$12,500,000, of which \$9,500,000 was made available for forest highways, an increase of \$5,000,000, more than doubling the annual sums formerly available.

In addition there was appropriated by the act of December 20, 1930, the sum of \$3,000,000 for the purpose of increasing employment. Altogether, the funds available for expenditure this year have been nearly three times as great as the previous authorizations.

An increase of the program of work so great as these additional appropriations required would normally involve a considerable period of preparation. A greater number of surveys must be made, and this, under the conditions that surround much of the forest road work, is a task that can not be dispatched in a moment. Plans in greater numbers must be prepared; contracts advertised and let and contractors' outfits moved to the remote places in which many of these projects are located, all with the additional handicap imposed by the short working season. And, first of all, so great a relative increase in the program can not be handled at all without some increase in the engineering force.

It is, therefore, gratifying to be able to report that, notwithstanding the readjustments necessary to meet the increased demands, the mileage of forest highways placed under construction during the fiscal year to be financed with the regular funds was about 75 per cent greater than in the previous year, and the entire amount of the \$3,000,000 emergency appropriation was obligated as required by the

end of the year. Several projects to be paid for with these funds were let to contract within a month of the date of the appropriation.

Most of the additional improvements made possible by the increase of \$5,000,000 in the regular appropriation have been located on the Federal-aid system or its more important extensions, that is class 1 and class 2 roads, and the type of improvement required has been higher than that which is adequate for class 3 roads. Because of this fact the costs have been somewhat above the average and the mileage that could be improved somewhat reduced. However, there has been a noticeable reduction in the level of prices for road work during the year and especially during the latter half. Bids received during this period encourage the belief that the low costs will permit adding to the 1932 program a number of projects which it had not been thought possible to include. To do so necessitates a number of additional surveys, but it is believed that these can be completed and the new work begun in time to allow the greater portion of it to be completed before it is necessary to suspend operations for the winter.

ROAD CONSTRUCTION IN THE NATIONAL PARKS

Appropriations authorized by Congress for the construction and improvement of highways in the national parks have steadily increased. For the fiscal year 1930 the expenditure authorized was \$3,500,000. For the year 1931 the amount of the regular appropriation was increased to \$5,000,000 and the emergency act of December 20, 1930, provided an additional \$1,500,000 for further relief of unemployment. For each of the fiscal years 1932 and 1933 appropriations of \$7,500,000 have been authorized. Of these latter sums Congress, by a recent act, has authorized the expenditure each year of \$1,500,000 for the improvement of roads outside of the parks but serving as approaches thereto.

The construction work of the past year, which by agreement with the National Park Service is supervised by the Bureau of Public Roads, has brought to completion 68.5 miles, making the total thus far improved 370.6 miles, all of which is in the system of major park roads that has been designated, including a total of 1,509.7 miles.

As required by the emergency appropriation act, all of the \$1,500,000 provided by it was obligated to definite projects by the end of the fiscal year in spite of the fact that it was necessary to make location surveys for the greater portion of the work before the projects could be advertised for bids.

The considerable increase in funds available for the last fiscal year accounts for the fact that the construction in progress at the end of the year covers 327.9 miles as compared with the program a year ago, involving only 67 miles. Of the current construction program 182.7 miles is stage construction.

The mileage included in the designated system in the several parks and the record of completion during the last year and to date are shown in Table 35.

TABLE 35.—*The program of national-park road improvement and the mileage of roads improved under the supervision of the Bureau of Public Roads*

National park	Mileage of the program	Mileage completed under the supervision of the bureau		National park	Mileage of the program	Mileage completed under the supervision of the bureau	
		During the fiscal year 1931	Total to June 30, 1931			During the fiscal year 1931	Total to June 30, 1931
Crater Lake.....	70.5	-----	23.3	Yellowstone.....	369.2	10.6	34.5
Glacier.....	145.9	-----	32.5	Zion.....	22.4	.4	9.1
Mount Rainier.....	122.1	7.4	49.1	Hawaii.....	83.6	-----	11.2
Grand Canyon.....	156.7	15.7	75.2	Mesa Verde.....	47.3	-----	6.0
Yosemite.....	218.6	10.9	47.4	Acadia.....	4.5	3.3	3.3
Sequoia.....	84.5	-----	25.2	Wind Cave.....	5.4	1.0	5.3
General Grant.....	-----	-----	4.0	Mount McKinley.....	73.5	-----	-----
Lassen Volcanic.....	39.5	19.2	35.5	Total.....	1,509.7	68.5	370.6
Rocky Mountain.....	64.4	-----	8.7				
Devil's Tower.....	1.6	-----	.3				

Probably the most interesting of the projects under construction is the Wawona Road in Yosemite National Park, which includes the construction of a tunnel approximately 4,200 feet in length. Contract for this work was awarded on October 1, 1930, and the project is now about 30 per cent complete. It is anticipated that all work will be completed in advance of the time stated in the contract.

The problem of ventilating the tunnel on this project has required considerable study, in which the bureau has received invaluable assistance from the United States Bureau of Mines. The preliminary report of that bureau indicates that mechanical ventilation will be required, and the Bureau of Mines will be asked to assist in the preparation of the plans for this.

Of outstanding interest among the projects completed during the past year are the south approach to Grand Canyon National Park and the Bright Angel Springs Road in Grand Canyon. In Mount Rainier Park the White River Road and sections A and B of the West Side Highway are among the most important grading projects completed during the past year. In Yellowstone Park the Artist Point section of the Grand Canyon Rim was completed. In the East the grading of the Cadillac Mountain Road in Acadia National Park, Me., was completed. The surfacing of this project is now in progress and covers a length of approximately 3.5 miles.

The most important bridge structure completed was Klickitat Creek Bridge on the White River Road in Mount Rainier National Park. This is a reinforced concrete barrel arch with cement-rubble masonry facing.

The end of the fiscal year found plans under way for road construction in the proposed Shenandoah National Park and Colonial National Monument, both in Virginia. Two contracts were awarded for grading approximately 45 miles of roadway in Shenandoah Park at a cost of approximately \$700,000. This is all pioneer road construction of the heavy mountain type. Road construction in that section of Virginia is extremely difficult. All grades were kept under 6 per cent wherever practicable and at one point the plans call for a tunnel about 600 feet long. In Colonial National Monument two projects will be put under construction this year. One covers the grading of a section of the proposed highway from Yorktown to

Jamestown Island and the other involves about 1,000,000 cubic yards of hydraulic fill. The length of this fill is about 5,600 feet and is composed of two major fills, one across Indian Field Creek, a distance of approximately 4,400 feet and one across Felgates Creek, a distance of approximately 1,200 feet. The National Park Service has allotted the bureau approximately \$527,000 for the construction of these two projects.

RESTORATION OF FLOOD-DAMAGED ROADS

In the last annual report record was made of the passage of acts appropriating various sums as reimbursements or contributions in aid of several States, these appropriations induced by the extraordinary conditions of necessity and emergency resulting from the unusually serious financial losses by such States through damage to or destruction of roads and bridges by floods in 1927 and 1929.

The States to which such aid had been offered at the time of submission of the last report were Vermont, New Hampshire, Kentucky, Arkansas, Louisiana, Mississippi, Missouri, Alabama, Georgia, and South Carolina.

To the first three a total of \$5,197,294 was made available expendable only upon work undertaken with the approval of the Secretary of Agriculture after the passage of the act.

To Arkansas, Louisiana, Mississippi, and Missouri a total of \$3,654,000 was made available not only for work done subsequent to the passage of the act but also for reimbursement of expenditures made by the States before the act was passed. In every case it is necessary that the State shall have expended or made available for expenditure State funds in an amount equal to the Federal reimbursement or contribution.

To the third group of States—Alabama, Georgia, and South Carolina—separate acts appropriated sums totaling \$2,971,628.50, from which a deduction of 2½ per cent was authorized to cover the cost of Federal administration. The total amount actually available to these States is, therefore, \$2,897,338. The expenditure of this money is authorized in the same manner as described in the cases of Arkansas, Louisiana, Mississippi, and Missouri.

Since the submission of the last report there has been appropriated by the second deficiency act for the fiscal year 1931, approved March 4, 1931, a fund of \$80,307 for similar relief of the State of Florida. The appropriation in this case is not subject to the 2½ per cent administrative deduction and, in the language of the act, is made as "a complete contribution and reimbursement in aid from the United States * * *."

The amounts of these several appropriations (less the 2½ per cent allowed for Federal administration in the case of Alabama, Georgia, and South Carolina), the amounts paid the States up to June 30, 1931, and the unobligated balance for each State are shown in Table 36. The amounts paid during the past year are reported in Table 37.

The mileage of road improved under these acts up to the end of the last fiscal year and the corresponding total cost and Federal payment are given in Table 38. Similar information for roads completed during the past year is presented in Table 39, and for roads under construction at the end of the year and approved for construction in Tables 40 and 41, respectively.

The mileage of the several types of flood-relief roads completed in the several States during the fiscal year 1931 is given in Table 42, and the total mileages completed, under construction, and approved for construction on June 30, 1931, classified by types and by States, are given in Tables 43, 44, and 45, respectively.

TABLE 36.—*Flood relief appropriated, amounts paid to States, and the unobligated balance of the appropriation on June 30, 1931*

State	Appropriated	Paid to the States to June 30, 1931	Unobligated balance
Vermont.....	\$2,654,000	\$2,654,000.00	-----
New Hampshire.....	653,300	624,142.44	-----
Kentucky.....	1,889,994	556,338.50	\$1,242,784.76
Total.....	5,197,294	3,834,480.94	1,242,784.76
Arkansas.....	1,800,000	1,052,178.29	592,971.26
Louisiana.....	967,582	533,668.20	143,811.18
Mississippi.....	628,000	345,266.57	282,733.43
Missouri.....	258,418	-----	130,865.95
Total.....	3,654,000	1,931,113.06	1,150,381.82
Alabama.....	¹ 1,618,500	430,282.33	1,132,283.11
Georgia.....	¹ 493,416	-----	389,830.93
South Carolina.....	¹ 785,422	-----	44,180.64
Florida.....	80,307	-----	80,307.00
Total.....	2,977,645	430,282.33	1,646,601.68
Grand total.....	11,828,939	6,195,876.33	4,039,768.26

¹ Does not include fund allowable for administration.

TABLE 37.—*Flood relief paid to the States during the fiscal year 1931*

State	Flood relief paid during fiscal year 1931	State	Flood relief paid during fiscal year 1931
Vermont.....	\$163,258.00	Mississippi.....	\$3,563.66
New Hampshire.....	60,796.55	Total.....	1,589,410.15
Kentucky.....	162,742.85	Alabama.....	430,282.33
Total.....	386,797.40	Grand total.....	2,406,489.88
Arkansas.....	1,052,178.29		
Louisiana.....	533,668.20		

TABLE 38.—*Total cost, flood relief, and mileage of roads improved to June 30, 1931*

State	Total cost	Flood relief	Mileage
Vermont.....	\$5,651,965.83	\$2,654,000.00	61.2
New Hampshire.....	1,412,316.37	653,300.00	29.0
Kentucky.....	1,225,402.88	539,156.95	64.5
Total.....	8,289,685.08	3,846,456.95	154.7
Arkansas.....	586,181.70	283,087.73	47.2
Mississippi.....	11,433.59	3,563.66	.3
Total.....	597,615.29	286,651.39	47.5
Alabama.....	280,250.82	137,971.44	32.8
Grand total.....	9,167,551.19	4,271,079.78	235.0

TABLE 39.—*Total cost, flood relief, and mileage of roads which were completed and final payment made during the fiscal year 1931*

State	Total cost	Flood relief	Mileage
Vermont.....	\$1,016,599.46	\$437,051.28	14.0
New Hampshire.....	77,546.44	38,773.22	2.2
Kentucky.....	646,773.47	261,528.13	38.6
Total.....	1,740,919.37	737,352.63	54.8
Arkansas.....	532,780.42	256,387.09	46.0
Mississippi.....	11,433.59	3,563.66	.3
Total.....	544,214.01	259,950.75	46.3
Alabama.....	53,278.72	24,485.41	3.1
Grand total.....	2,338,412.10	1,021,788.79	104.2

TABLE 40.—*Total cost, flood relief, and mileage of roads under construction on June 30, 1931*

State	Estimated total cost	Flood relief allotted	Mileage
Alabama.....	\$41,929.57	\$20,964.87	8.7
Arkansas.....	65,489.09	28,405.38	.2
Kentucky.....	175,131.12	49,152.29	2.8
South Carolina.....	739,655.96	330,241.34	6.6
Total.....	1,022,205.74	428,763.88	18.3

TABLE 41.—*Total cost, flood relief, and mileage of roads approved for construction on June 30, 1931*

State	Estimated total cost	Flood relief allotted	Mileage
Alabama.....	\$3,624.03	\$1,812.01	0.1
Arkansas.....	201,046.13	99,744.43	2.6
Georgia.....	207,169.78	103,584.88	3.7
Kentucky.....	128,234.67	58,900.00	15.4
South Carolina.....	1,008,511.62	411,000.00	14.3
Total.....	1,548,586.23	675,041.32	36.1

TABLE 42.—*Mileage of the various types of flood-relief roads completed and final payment made during the fiscal year 1931*

State	Graded and drained	Sand-clay, untreated	Gravel, untreated	Macadam, treated	Bituminous macadam	Portland cement concrete	Bridges and approaches	Total
Vermont.....			0.8		2.6	9.9	0.7	14.0
New Hampshire.....				2.2				2.2
Kentucky.....	38.2						0.4	38.6
Arkansas.....	15.8		28.8			.3	1.1	46.0
Mississippi.....						.3		.3
Alabama.....	2.2	0.8					.1	3.1
Total.....	56.2	.8	29.6	2.2	2.6	10.5	2.3	104.2

TABLE 43.—*Mileage of the various types of flood-relief roads improved to June 30, 1931*

State	Graded and drained	Sand-clay, untreated	Gravel, untreated	Gravel surface treated	Macadam surface treated	Bituminous macadam	Portland cement concrete	Bridges and approaches	Total
Vermont.....			7.0	9.2		6.1	32.5	6.4	61.2
New Hampshire.....				2.9	4.9	2.3	18.3	.6	29.0
Kentucky.....	63.8							.7	64.5
Total.....	63.8		7.0	12.1	4.9	8.4	50.8	7.7	154.7
Arkansas.....	15.8		30.0				.3	1.1	47.2
Mississippi.....							.3		.3
Total.....	15.8		30.0				.6	1.1	47.5
Alabama.....	19.1	0.8	12.3					.6	32.8
Grand total.....	98.7	.8	49.3	12.1	4.9	8.4	51.4	9.4	235.0

TABLE 44.—*Mileage of the various types of flood-relief roads under construction on June 30, 1931*

State	Graded and drained	Sand-clay untreated	Portland cement concrete	Bridges and approaches	Total
Alabama.....	8.6			0.1	8.7
Arkansas.....				.2	.2
Kentucky.....	2.6			.2	2.8
South Carolina.....	.1	0.4	5.0	1.1	6.6
Total.....	11.3	.4	5.0	1.6	18.3

TABLE 45.—*Mileage of the various types of flood-relief roads approved for construction on June 30, 1931*

State	Graded and drained	Gravel untreated	Macadam surface treated	Portland cement concrete	Bridges and approaches	Total
Alabama.....				0.1		0.1
Arkansas.....		1.7			0.9	2.6
Georgia.....			3.3		.4	3.7
Kentucky.....	15.4					15.4
South Carolina.....	12.1			.3	1.9	14.3
Total.....	27.5	1.7	3.3	.4	3.2	36.1

MOUNT VERNON MEMORIAL HIGHWAY

Construction of the Mount Vernon Memorial Highway, begun in September, 1929, has proceeded rapidly during the last fiscal year and it is now virtually assured that the road will be ready for travel throughout when it is dedicated as a memorial to George Washington in 1932. The ceremony, which is a part of the program of the United States Commission for the Celebration of the Two Hundredth Anniversary of the Birth of George Washington, will be held on April 30, 1932.

With the exception of the construction of about 2¼ miles of hydraulic fill forming part of the grade of the highway, all work

has been done under contract. The hydraulic fill construction has been done by the Corps of Engineers of the United States Army, in a highly efficient manner, and at a cost but little exceeding the estimate, a result which is especially gratifying because the subsurface conditions proved to be unfavorable and the work of constructing the fills rather difficult. The soft, unstable material in the bed of the streams at the points where the fills were constructed ranged from 12 to 30 feet in depth. But, despite the unanticipated difficulties encountered, and the extra yardage which has been placed in the fills, the work—virtually completed at the close of this fiscal year—has been done at little more than half the cost for the same work on the basis of the one complete contract bid received and rejected before the work was undertaken by the Corps of Engineers. Up to June 30 the expenditure for this work was approximately \$1,200,000 and this amount is estimated to be within \$100,000 of the final cost.

On other portions of the work for which contracts have been awarded the progress up to June 30 was as follows:

Unit 1. Construction of a sea wall and cofferdam and supply of stone for bridge facing. Contract awarded September 12, 1929. Work completed and accepted May 11, 1931.

Unit 2. Dry-land grading, drainage, and incidental construction: Contract awarded February 11, 1930. Work completed and accepted May 9, 1931.

Unit 3. Bridges: Contract awarded April 17, 1930. This contract involves the construction of 11 bridges and a new abutment for the existing Highway Bridge over the Potomac River. Progress on these structures has been as follows:

Boundary Channel bridge, approximately 70 per cent complete on June 30.

New abutment for Potomac River Highway Bridge, approximately 90 per cent complete on June 30.

Highway underpass at south end of Potomac River Highway Bridge, approximately 95 per cent complete on June 30.

Highway underpass at Richmond, Fredericksburg & Potomac Railroad, approximately 97 per cent complete on June 30.

Bridge over Roaches Run, complete on June 30.

Bridge over Four Mile Run, complete on June 30, except for final pointing and cleaning.

Airport overpass, complete on June 30.

Southern Railway overpass, completed on June 30, except for final pointing and cleaning.

Bridge over Hunting Creek, approximately 97 per cent complete on June 30.

Wellington underpass, practically completed on June 30.

Fort Hunt overpass, complete on June 30.

Bridge over Little Hunting Creek, approximately 98 per cent complete on June 30.

Unit 4, section 1. Paving and incidental structures from Columbia Island to the south side of Hunting Creek: Contract awarded March 11, 1931. Paving begun May 12. Progress satisfactory.

Section 2. Paving and incidental structures beginning at the south side of Hunting Creek and terminating at Mount Vernon. Contract awarded March 20, 1931. Paving begun April 21. Progress satisfactory.

In addition to the above major contracts others awarded before the close of the fiscal year provided for the construction and operation of a concession building at the highway terminus at Mount Vernon, and for the drilling and casing of a well at the terminus. The former was awarded on June 23; the latter on June 25.

Other contracts to be awarded shortly will provide for construction incident to a water supply at the terminus and for the erection of lighting fixtures along the highway.

The landscaping and planting work which forms an important part of the project is being done mainly by force account under the direction of the Bureau of Public Roads and is progressing satisfactorily.

Provision for the construction of the highway from Washington to Mount Vernon as a memorial to George Washington was made by the act of Congress, approved May 23, 1928, which authorized the United States Commission for the Celebration of the Two Hundredth Anniversary of the Birth of George Washington to survey, select, construct, and maintain the road in cooperation with the Secretary of Agriculture.

The appropriation originally authorized for the work was \$4,500,000. By act of March 4, 1931 there was authorized an additional appropriation of \$2,700,000. All funds authorized have since been appropriated.

INTER-AMERICAN HIGHWAY

Work on the reconnaissance surveys of the proposed inter-American highway from Panama to the United States progressed materially during the past year. Engineers of this bureau, cooperating with the several governments which have requested such surveys, have inspected possible locations of the highway through the countries of Panama, Costa Rica, Honduras, and Guatemala. A similar survey will be made in Nicaragua during the coming fiscal year.

This important activity had its inception in recommendations of the Sixth International Conference of American States, held at Habana, Cuba, in 1928, and the Pan American Congress of Highways which met in Rio de Janeiro in 1929, for consideration and adoption of agreements looking to the construction of a pan-American highway connecting North America, Central America, and South America. More specific action was taken at an inter-American highway conference in Panama October 7-12, 1929, when a resolution was adopted recommending the creation of a commission to carry on the work of determining the most feasible route of an inter-American highway. By act of Congress, approved March 26, 1930, the United States Government appropriated \$50,000 to defray the cost of reconnaissance surveys to develop the facts, and to report to Congress on the feasibility of possible routes, the probable cost, the economic service, and such other information as would be pertinent to the building of an inter-American highway or highways.

Under this authority three bureau engineers took up their duties in Central America in June, 1930, headquarters having been provided at Panama through the courtesy of the Panamanian Government. These engineers have continued their work throughout the fiscal year just ended, as previously outlined. In March, 1931, the Inter-American Highway Commission met again at Panama to learn of the progress of the work, with the chief of this bureau and the chief of the bureau's division of highway transport, which is in direct charge of the reconnaissance operations, in attendance.

Field work on the reconnaissance survey will be completed during the coming fiscal year, it is expected, and a comprehensive report will then be made for submission to Congress.

SIXTH INTERNATIONAL ROAD CONGRESS

The Sixth International Road Congress which was held at Washington from October 6 to 11, 1930, proved to be one of the most interesting and important meetings of the Permanent International Association of Road Congresses.

The congress was held in the United States at the invitation of this Government, which holds membership in the association. The chief of this bureau, by appointment of the Secretary of State, served as the secretary-general of the American organizing commission, an agency of the State Department created to administer the appropriation of \$55,000 made by Congress to defray the expense of the sessions.

Because of its close association with road work in the United States this bureau was called upon by the Department of State for advice and assistance in preparation for the congress and in assisting and informing the engineers who were in attendance from 64 countries.

TRANSPORTATION AND ECONOMIC AND STATISTICAL INVESTIGATIONS

WESTERN STATES TRAFFIC SURVEY

The survey of traffic on the Federal-aid highway system in 11 Western States, which was begun during the autumn of 1929, was completed in October, 1930, after one year's field work. A complete report on this project, including many tables and maps with explanatory text, is now being compiled.

The States in which the survey was conducted were: Arizona, California, Colorado, Idaho, Nebraska, New Mexico, Nevada, Oregon, Utah, Washington, and Wyoming. In each State the work was done in cooperation with the State highway department.

This project has been the largest of the kind yet undertaken by the bureau, although numerous surveys covering single States or municipal regional areas have previously been made. It has developed the first accurate information available in regard to the flow of traffic on the principal highways of nearly the entire western half of the United States, thus forming the basis for a broad plan of highway improvement in this area.

Among the important data obtained through this survey may be cited the following: Daily average of traffic on all Federal-aid roads in the States surveyed, and traffic data on numerous other roads connecting with the Federal-aid system; estimates of probable future growth of traffic at 5 and 10 year intervals; analysis of the types of vehicles which comprise these totals—passenger automobiles, trucks, or buses; number of persons transported by the passenger-carrying vehicles, and the various capacities of trucks; average daily length of trip of various types of trucks and of passenger cars; number of common-carrier and contract-hauler trucks; origin and destination of vehicles; and percentages of interstate and intrastate traffic.

The scope of the survey is indicated by the fact that more than 20,000,000 vehicles were observed during the year of field work.

MICHIGAN TRAFFIC SURVEY

Another type of traffic survey was conducted in Michigan in cooperation with the highway department of that State, primarily for the purpose of determining facts regarding the character and distribution of traffic on State and local roads and city streets, which may have a bearing upon the future distribution of the cost of highway improvement within the State. Field work on this project began in July, 1930, and its completion, including an extra month of intensive traffic counts in seven leading cities of the State, was scheduled for the end of August, 1931, after which a report is to be compiled and published.

Important facts relating to current problems of highway finance will be produced by this survey, it is expected. The relationship between the use of primary and secondary roads and city streets by various classes of traffic and the source of the funds employed in their improvement and maintenance has never been accurately determined. The assumption generally made is that traffic on the main intercity roads is a comparatively far-ranging traffic, mostly of city-owned vehicles, and that local roads serve a traffic that is predominantly of intracounty origin.

In recent years, however, increasing demands that a larger portion of State-collected revenue be applied to the improvement of local roads have been made by county and township authorities, their claims being predicated upon the assumption that the local roads are required to serve a considerable traffic from outside the local taxing jurisdiction and that the State as a whole should compensate the local government in greater measure for the highway service thus afforded to other than local vehicles. The purpose of the survey in typical townships of Michigan is to ascertain the facts that will indicate whether there is just and reasonable basis for these demands. Cities also claim a share of State revenues in consideration of the use of their streets by rural vehicles, and the special intensive survey in seven representative cities during August bears particularly upon this phase of the problem.

STUDY OF TAXATION IN WISCONSIN

A study, somewhat similar to the investigation in Michigan, but differing in method, was conducted and completed during the year in Wisconsin, the bureau cooperating with the University of Wisconsin.

This investigation was undertaken to determine the facts of highway financing in the State as a whole, with special reference to the true incidence of highway taxation by classes of governmental units and the relationship of highway taxation to taxation for all other purposes. Special effort was made to ascertain where highway funds of all classes were expended, both by road systems and by groups of units of government, and also to establish approximately by a questionnaire method the distribution of highway travel both by road systems and groups of governmental units.

The study, which is later to be extended to other States, was undertaken first in Wisconsin because of the excellence and completeness

of that State's fiscal and tax records. A full report of the work in this first State has been prepared and will shortly be ready for publication.

HIGHWAY TRAFFIC-CAPACITY INVESTIGATIONS

The cooperative agreement with the University of Maryland for a study of highway capacity has been renewed for a second year. The continuation is for the principal purpose of accumulating additional field data to verify that previously compiled. Analysis of last year's observations leads to the tentative conclusion that there is no serious amount of congestion on 2-lane roads up to a traffic rate of about 1,000 per hour, nor on 3-lane roads up to a rate of about 1,600 per hour. In these studies the formation of queues, indicating that the density of traffic is such as to prevent prompt passing of overtaking vehicles, is taken as the criterion of a condition of congestion.

STUDY OF COMMERCIAL TRUCK OPERATION

In cooperation with the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce, an investigation of commercial motor-truck operation, initiated during the preceding year, has been brought nearly to completion. Personal interviews with motor-truck operators in all parts of the United States have yielded a valuable body of detailed data, covering equipment in use, radius of haul, and cost of service. Other general information essential to a clear description of the industry has also been assembled for incorporation in a report.

GENERAL HIGHWAY STATISTICS

General statistics relating to road mileage, annual construction programs, State and local highway funds and disbursements, motor-vehicle registration, proceeds from motor-vehicle and gas taxes, motor-vehicle and gas-tax rates, gasoline consumption, State highway bond issues, and highway-bond financing are regularly collected and published in a series of annual tabulations. This material is assembled by no other agency of the Federal Government or States, and its collection is essential to the proper administration of Federal-aid road work. The information is in constant demand by other agencies of the Government, by the States, and by the public.

PRODUCTION COST STUDIES

Unit costs in most lines of highway-construction work are very largely controlled by the rate of production. This is because the daily or hourly cost of operating a modern road-building plant is practically independent of the rate of production so long as the crew and plant are on the job. Consequently, the most effective way to reduce unit operating costs is to increase the rate of production, for as the rate of production increases the unit cost of the work decreases in very nearly the same ratio.

In order to determine definitely how much the rate of concrete road production with standard 27-E pavers could be increased by increasing the size of the batch without any injury to the quality of the concrete, a series of extensive field tests was conducted in co-operation with the highway departments of several States. These tests show conclusively that the more modern 27-E concrete pavers can handle without difficulty a batch at least as large as 35 cubic feet without any sacrifice of either strength or uniformity. The tests further demonstrated that a 33-cubic-foot batch, when mixed during the period indicated by a batchmeter setting of 50 seconds, produced as strong and uniform concrete as did the standard batch when mixed either 50, 60, or even 80 seconds. On the basis of these studies, the State highway department of Wisconsin adopted as its standard a 33-cubic-foot batch with a mixing time of 50 seconds. These specifications make possible an increase in actual production of approximately 27 per cent over the previous specifications, which required a mixing time of 60 seconds and a batch of not to exceed 30 cubic feet. Wisconsin is the second State to adopt officially a mixing time of 50 seconds, California being the first.

But the so-called "mixing time" or time during which all the materials must be in the mixer and subject to the mixing action is not all of the mixing cycle. Time is also required to get the batch into the mixer and out of it. In controlling the rate of production this charge and discharge time is proportionately just as important as the mixing time. For some time it had been noticed that the discharge time of the larger "pugmill" type of mixers generally used in sheet asphalt and bituminous concrete work was very long. Recent improvements, based largely on the bureau's studies and suggestions, have not only improved the mixing action of this type of mixer, but have reduced the discharge time by more than half, thus materially increasing the possible rate of production. Other improvements, long advocated by the bureau's division in charge of this work, include a positive control of the length of the mixing time, and a faster and more uniform method of operation and control of the charging of the batch. These have been added to the new mixers.

The general aim in this work is to find and develop means and methods which will increase production without impairing the quality of the finished product. Quality is always held to be the first essential. No methods, however promising as to speed or unit cost, are tolerated if they show any indication of reducing the quality of the finished product below the specified standards.

The field studies of direct production problems have been continued with gratifying results. These studies relate, (1) to the elimination or reduction of time losses in the performance of all direct operation, (2) to the coordination and synchronization of the rate of production of the various subsidiary or dependent operations with that of the key equipment, and (3) to eliminating unnecessary operations and expediting those which are really necessary. To give these studies immediate practical value to the highway industry the engineers of the bureau work almost entirely on selected, typical construction projects and in close cooperation with the contractor, his superintendent, and the various highway officials in charge of the work. Nothing is permitted which might in any way reduce the quality below the standards called for in the contract. But with the main-

tenance of quality established as the first essential, all other conditions are studied and analyzed in order to determine the causes which are operating to hold down production and then to devise means for their reduction or elimination.

The extent to which the construction industry can and does profit from these studies is well illustrated by the following example: In the fall of 1929 two engineers were assigned to study a large asphaltic construction project in Monterey County, Calif. This organization was already known for its excellent methods, skilled supervision, and high rates of production, and when the engineers were assigned it was the intention that they should observe and study the possibility of adapting these methods to more general use. However, a thorough analysis of the production processes disclosed opportunities for still further improvement. The management, which was especially alert, at once seized these opportunities with the result that what was then a State-wide record of 802 tons of asphaltic concrete placed per 8-hour day was established as an average for the entire job. But the engineers felt sure that this was not the limit of what this organization was capable of producing. Consequently, this same organization was again studied on another job early in 1930. On this job a more thorough elimination of all time losses and a better synchronization of the various operations resulted in raising the average rate of production to 927 tons per 8-hour day.

Neither the engineers nor the management yet felt that the final production limit of this organization had been reached, and a third study was undertaken during the fall of 1930. Opportunities to increase the rate of production were again found and utilized, with the result that the average rate of production per 8-hour day for the entire period from August 18 to October 8 was raised to what was then, so far as is known, a world record of 1,204 tons per day.

The really significant thing about these studies, however, is not the fact that the rate of production of an already highly efficient organization was increased 50 per cent, but that it was found possible to obtain this increased production without any appreciable increase in the daily operating costs. Consequently, the decrease in unit operating costs was of real moment.

Of course, not all jobs on which studies have been conducted have yielded such gratifying improvement in the rate of production. On the other hand, very few projects have been found on which some definite increase could not be obtained without corresponding increase in the cost of operation. The possibilities can be appreciated from the fact that on what might be called average jobs, nearly half of the time of the crew is unproductive as measured by the possible output of the mixer, while on the above-mentioned project on which asphaltic concrete was placed at an average rate of over 150 tons an hour, less than 3 per cent of the crew's time on the job was unproductive.

The number of contractors with whom the bureau can cooperate in actual demonstrations of this kind is limited, but the benefits are nevertheless very far-reaching. The better methods of operation developed during the studies at once become the standard practice of the individual contractor on his future work, and under the prevailing keenly competitive conditions existing in the highway industry, improved methods are quickly noted and copied by others.

Definite information on the methods and principles developed in this work is also disseminated from time to time through reports and papers read before meetings of highway engineers, contractors, and technical societies, or published in the technical journals. In these ways the benefits of these studies are being widely extended and the principles and methods developed are being put into successful operation by an increasing proportion of the most progressive road builders.

HIGHWAY ACCOUNTING METHODS

During the past year the bureau has assisted several State highway departments in the development and installation of uniform accounting and statistical procedures designed to supply full and complete records of income, expenditures, and accomplishments in construction, maintenance, and administration. Standard definitions have been developed which cover the various activities in which the several highway departments are engaged. These serve as a basis for setting up a system of accounts and records which will fully meet all the accounting requirements of the department and at the same time provide in readily available and practical form complete statistical information on any desired line of activity. These accounts and records are based on the use of the most modern bookkeeping and tabulating equipment in order to give prompt and accurate service at the lowest possible cost. The general adoption of such uniform systems of accounts and records will not only be of great value to the individual State in planning and carrying on its various activities, but will also make possible an intelligent comparison of the cost of various methods and kinds of road construction and maintenance as carried on in the several States, a comparison which is not at present possible because of the dissimilar form of the available records. During the year assistance of this kind has been given to the States of Florida, Georgia, Indiana, Mississippi, Oklahoma, and Tennessee.

Assistance was also given to the State of North Carolina in formulating a more efficient and economical method of administrative and financial control of all the more important former county or township roads of the State. The background for this plan included a survey of the financial records of every county with special regard to road revenues, road expenditures, and road indebtedness. A map of each county was also prepared showing all the public roads divided into three classes according to their traffic importance. This information was laid before the State legislature, which enacted a new highway law placing all the more important former county roads under the direct control of the State highway department.

PHYSICAL RESEARCH

SUBGRADE INVESTIGATIONS

Previous reports have described the general problems involved in the subgrade investigations and the steady progress which has been made in their solution. During the last year these investigations have been continued, as in the past, with the cooperation of the Bureau of Chemistry and Soils and various State highway departments and educational institutions.

The work which has been done has been confined in large part to studies of the underlying physical and chemical laws which control the characteristics of soils, and the identification and classification of soils with respect to their performance in highway subgrades. As progress has been made it has become increasingly apparent that the identification of soils with respect to their performance as subgrades and the application of this knowledge in practical road construction constitutes a specialized branch of highway engineering which is extensive in scope and intricate in character. It includes the classification of soils according to the requirements of various kinds of service and the development of tests which disclose the degree to which soils may perform the service required. It has practical application in the solution of a wide range of problems varying, for instance, from the design of satisfactory sand-clay road surfaces to the methods of constructing massive fills.

In one case the answer to a specific subgrade problem may be furnished merely by visual inspection of the soil in the field. In other cases, comprehensive investigations of the soil both in the field and in the laboratory may be required to furnish the desired information.

The manner of making cuts and constructing fills, the degree to which the subgrade should be compacted or otherwise manipulated, the means which will best furnish the required degree of compaction or manipulation, the proper proportions in which soils of different character may be combined to produce stable subgrades, the decision as to whether a subgrade soil shall be treated or replaced with a better material and the depth of treatment or replacement, all depend on fundamental characteristics of the soil.

In addition, specific subgrade problems are influenced to a large degree by local climatic conditions and the arrangement of soils in the soil profile. This is illustrated by the requirements for the design of adequate drainage systems. The failure of subdrains to furnish the desired stability of subgrade soils may be attributed in many instances to the practice of placing them according to arbitrary standards of spacing and depth, without due regard to such factors as the source of water to be removed, the character of soils in the several soil layers and the arrangement of these layers in the soil profile. As research in soils has progressed the hopelessness of standardizing drainage design, on the basis of such simple requirements as the spacing and depth of underdrains, has become evident.

The various problems relating to the best utilization of soils in highway construction are so complex as to require for their solution the services of men specially trained in this work. Moreover, the most effective application of the knowledge which has been developed can best be secured by the various State departments charged with the responsibility for highway construction, by assigning the study of subgrades and the solution of subgrade problems to specially trained men in the State organizations.

One of the important services now rendered by the bureau is the assistance which is being given to State highway departments which desire it, in training men for the subgrade work, and helping to organize intensive subgrade study by the departments themselves. From time to time special courses of instruction in field and labora-

tory procedures and the interpretation of test results are given at the subgrade laboratory of the bureau at the Arlington Experiment Farm, at Rosslyn, Va., to employees of State highway departments authorized to attend and, when requested, subgrade specialists of the bureau are assigned to cooperate with State highway departments in the organization of subgrade divisions. The number of States which have taken advantage of this assistance, and have organized independent subgrade investigations, is very gratifying.

Much of the previous work, such as studies of frost heaving, loss of stability, and detrimental volume-change of soils, has been of a general nature for the purpose of determining fundamental properties. The investigations are being broadened gradually as circumstances warrant to include more specific problems, such as the warping of concrete pavements which has been observed on certain types of heavy soils, the disintegration of concrete in pavements as it may be affected by subgrade constituents, and the methods most suitable for compacting earth fills of various types of material. The aim of these later studies is to determine preventive measures or methods of construction best suited to the local conditions encountered.

During the year instructive reports have been published and others have been prepared for publication during the coming year.

LOW-COST ROAD INVESTIGATIONS

The construction of satisfactory road surfaces of low cost to serve the lighter traffic of the secondary roads has been an increasing activity of State highway departments for several years. The bureau has been active in investigations designed to produce additional information on the most effective use of available materials in roads of this character and these studies are being continued.

An experimental project in California, conducted in cooperation with the division of highways of the California Department of Public Works, has been described in previous reports. Construction of the experimental road was completed during the summer of 1930, and the various sections are now under observation. Publication of a progress report during the next year is contemplated.

Construction of an experimental road in the sand-hill area of Nebraska, also described in previous reports, was completed during the summer of 1930. A progress report describing the construction and the early behavior of the experimental sections will be prepared for publication during the coming year.

Observations have been continued on three projects in South Carolina which were constructed and are maintained by the State highway department in cooperation with the bureau. These projects have a total length of about 32 miles and include 55 experimental sections. One of the projects was discontinued at the close of the fiscal year on account of partial relocation of the road and reconstruction with a higher type of surfacing. A final report on this project will be prepared for publication next year. A progress report on one of the remaining projects is ready for publication, and an early report on the other project is contemplated.

The cooperation with the Asphalt Institute in the study of the uses of asphalt in low-cost road construction, described in some detail in previous reports, has been continued. During the year

cooperative arrangements have been made with representatives of the tar industry for a similar study of the uses of tar, and a field survey of tar-treated roads in North Carolina has been completed.

A most important cooperative study, having as its object the ultimate simplification and standardization of specifications for the liquid asphaltic materials which are used so extensively in low-cost road work, and involving the Bureau of Public Roads, the State highway departments, and the asphalt industry, has been inaugurated during the past year. For materials of this character, the great number of specifications for products intended for similar purposes, and the lack of agreement regarding methods of testing and test requirements, has created a confusion which is detrimental to the best interests of both producer and consumer. By means of cooperative tests of a great number of samples of liquid asphalts of all classes, made in accordance with a common scheme of analysis and also in accordance with the specification requirements of the various State highway departments, there is being accumulated a mass of data relative to the fundamental properties of these materials. These data will be used as a basis for future agreements on uniform test procedures and uniform specification requirements.

MOTOR VEHICLE IMPACT INVESTIGATIONS

From the standpoint of road design two important changes in the character of heavy motor vehicle traffic are taking place. The first of these is the general adoption of pneumatic-tire equipment and the second is the general increase in operating speeds.

To determine what impact reactions may be expected from heavy, high-speed trucks and buses an investigation has been conducted in which a modern bus chassis, carrying certain loads and equipped with various types of tires, was driven at speeds up to 55 miles per hour over definite conditions of pavement roughness and the impact reactions measured. From these tests definite information concerning the magnitude of the impact reactions developed by vehicles of this type was obtained and the effect of such variables as road roughness, load, speed, tire type, rim width, and inflation pressures was established. This valuable material has been made available in a published report.

The three reports of various other phases of this work, which were described in the last annual report as having been prepared for publication, were published also during the past year.

INVESTIGATION OF CONCRETE PAVEMENT DESIGN

Because of the great amount of money being expended for the construction of concrete pavement, possible improvement in the structural design of pavement slabs is a matter of considerable economic importance. The proper cross section to be used has never been established with precision and there is very little reliable information for the design of effective longitudinal and transverse joints.

In order to provide information on these features of pavement design, 10 concrete slabs, 20 by 40 feet, have been constructed at the Arlington Experiment Farm. These are of various shapes of cross

section and include various joint designs. On these slabs known loads are being placed and the effectiveness of the different designs determined by observation of the stresses and deflections which result from these loads. A comparison is being made between the observed behavior of these slabs under load and that which should theoretically occur. A study of the effect of temperature on the size and shape of the sections is also being made. The data which are being obtained should be of considerable assistance in developing a rational method of concrete pavement slab design.

INVESTIGATIONS OF CONCRETE AND CONCRETE AGGREGATES

The investigation of paving concrete involving the construction of an experimental road one-half mile in length, to which reference was made in the annual reports for the preceding two years, has been completed and a report issued. These studies are of special interest because they have made it possible for the first time to base conclusions upon tests of the actual pavement as well as upon tests of small-size specimens. In this way valuable information has been obtained regarding the significance of certain routine tests which have been applied to concrete for many years and which have so far been the only basis upon which it has been possible to proportion concrete mixtures.

Certain of the more important conclusions derived from this investigation follow:

For a constant sand-cement ratio, both the average strength and the uniformity in strength of a concrete pavement slab will be decreased by increasing the percentage of coarse aggregate in the mixture beyond the amount ordinarily used in practice.

When very dry mixtures are used (less than 2-inch slump) the strength of the pavement slab will be lower and the amount of honeycomb in the concrete will be greater than when concrete of medium consistency is employed (2 to 3 inch slump).

Tests made on small molded specimens are a reasonably satisfactory measure of the strength of the concrete in the pavement provided the concrete is of medium consistency. For very dry mixtures the strengths obtained on molded specimens are apt to be higher than the strength of the pavement.

The amount of honeycombing observed in cores drilled from the pavement does not necessarily measure the amount of honeycombing in the pavement itself.

Investigations of paving concrete will be continued during the coming year and will include a study of the effect of using high-speed electric vibrators for compacting the concrete; a study of the effect of continued surface manipulation of the concrete by hand for the purpose of removing excess water; and, a study of the effect of hydraulic lime on the strength and workability of concrete.

Investigations of factors affecting the durability of concrete are being continued. As stated in the report of last year, studies of this character are of long duration because of the time necessary to produce in the laboratory conditions which are comparable with actual weathering. The problem has likewise been complicated because of lack of information on the proper methods of testing to be employed. For this reason the first experiments conducted by the bureau along this line have proved of value chiefly in throwing light on the

problem of a standardized test procedure. It is hoped that, as a result of these preliminary tests, it will be possible to establish in the near future a standard method of test which may be used in investigating the resistance of concrete to weathering action.

During the year a study of methods of testing sand to be used in concrete was conducted in cooperation with technical committees of the American Society for Testing Materials and the American Association of State Highway Officials. This study has resulted in the development of a method of test, based on the well-known water-cement ratio law, which has been adopted as a tentative standard by both of these organizations.

The increasing use of the flexure test for determining the strength of concrete has called for standardization of a laboratory method of test. An investigation of a method proposed as a standard by the American Society for Testing Materials has recently been completed by the bureau and the results will be reported during the coming year. These tests were for the purpose of determining the effect of certain variables, such as size of test specimen, method of loading, etc., upon the test results.

A series of tests involving the construction of concrete test walls of various heights, for the purpose of determining the effect of segregation during placing, was also concluded during the year. This problem is of importance in bridge construction, as well as in other concrete works where it is necessary to fill deep forms in a continuous operation, and where there is a tendency of the water in the concrete to rise to the top as the form is filled, resulting in concrete of nonuniform composition. In this series of tests concrete of a single proportion was used and the sand was rather fine. The forms varied in depth up to 12 feet. Under these conditions it was found that segregation or water gain was negligible even when mixes having slumps as high as 8 inches were used. It is probable that further tests, using forms of considerably larger cross section and with a coarser sand, will reveal a more pronounced tendency toward segregation.

This investigation presented an opportunity to obtain a limited amount of data on the effect of vibration, for the consolidation of fresh concrete, on the pressures developed against the formwork. This is of particular importance in the design of deep forms, such as those for the spandrel columns of arch bridges, when the use of vibratory methods of consolidation are contemplated. The indications of the data are very definite and a report of this phase of the investigation has been published.

HIGHWAY BRIDGE INVESTIGATIONS

In cooperation with the authorities of Allegheny County, Pa., an investigation has been made of two lightweight steel and concrete bridge-floor slabs of similar type. Slabs of this type have shown satisfactory structural strength under static loads, but the question arose as to the effect of impact of motor vehicles on the structural behavior. Floor slabs about 15 feet square, supported by typical steel beam and stringer construction, were subjected to a very complete series of static and impact loadings. A report of this project will be published during the coming year.

The program of bridge-floor slab tests carried on in cooperation with the Port of New York Authority and described in the last two annual reports has been completed and the report approved for publication.

In the last annual report mention was made of the investigation of the Freyssinet method of concrete-arch construction to be made in cooperation with the Oregon State Highway Commission. The field work in connection with this project will have been completed by the end of the construction season of 1931 and it is anticipated that a report will be available for publication before the close of the next fiscal year.

DIVISION OF AGRICULTURAL ENGINEERING

IRRIGATION INVESTIGATIONS

DUTY OF WATER

All of the Western States are interested in utilizing to greatest advantage the available supplies of irrigation water, and most of them have been cooperating with the Bureau of Public Roads in studies relating to duty of water. These involve particularly investigations as to the amounts of water required for most economical production of crops, the prevention of waste in applying the water to the crops, and net irrigation requirements of lands under various physical, climatic, and agricultural conditions.

The investigations of water losses by evaporation and transpiration of plants in the delta of the San Joaquin and Sacramento Rivers, in cooperation with the Department of Public Works of California, have been continued. The field work has been completed, except for some special tank experiments to observe certain transpiration phenomena in weed and tule areas. The results of these investigations are to be published by the department of public works. A manuscript on Research into Rainfall and Evaporation and Transpiration Losses and their Relation to Irrigation in the Santa Ana Basin was prepared, in cooperation with the same State department.

A bulletin on Cost of Irrigation Water in California was issued during the year by the department of public works of the State, making available the results of studies carried on cooperatively by that department, the College of Agriculture of the University of California, and the Bureau of Public Roads. The costs to farmers are shown to have ranged in 1929 from 37 cents to \$84.33 per acre, and from 30 cents to \$116.45 per acre-foot. Costs generally were lowest in central California and were highest in the southern part of the State, particularly for isolated tracts in the Sierra foot hills.

A new study to determine the effect of certain types of irrigation and of various applications on cotton and rice was begun in cooperation with the College of Agriculture of the University of California. Growers of these crops also cooperated, informally. Owing to the extreme shortage of irrigation water, it is doubtful if any definite data will be forthcoming before another irrigation season has passed.

In southern California the duty-of-water studies embrace the use of water by both cultivated and native wild plants; evaporation from

soil and water surfaces; rainfall penetration on the valley floor; and other phases of the most economical use of water. In cooperation with the Bureau of Plant Industry and the Forest Service, studies have been begun to determine the water requirements of types of trees and shrubbery growing in canyon bottoms or stream beds. Results so far indicate that water losses through use by river-bottom vegetation in two summer months may equal the annual irrigation requirement of an orange grove of equal area.

The study of duty of water in the Rogue River Valley in Oregon, with special reference to pears, which was started during the fiscal year 1930, has been continued through this fiscal year, and has been considerably enlarged because of developments resulting from the earlier studies. This project is maintained cooperatively by the division of agricultural engineering, the Oregon Agricultural Experiment Station, and Jackson County. The last named has just purchased a completely equipped orchard for use in these experiments. Arrangements have been made for participation of the Bureau of Plant Industry in these studies during the coming year.

WATER SPREADING FOR UNDERGROUND STORAGE

Long before the present cycle of dry years which has resulted in a serious shortage of irrigation water, underground storage of water had been considered an urgent problem, but it had been treated in only a casual way. In many parts of southern California, in one region of central California, and in certain small areas in Arizona, Colorado, and Utah some work had been done toward conserving surface run-off by spreading it to percolate to the underground water table where it could be stored and pumped back to the surface when required. In 1930 the division established its first experimental plot and in 1931 completed two check plots at the mouth of San Gabriel Canyon in Los Angeles County, Calif. These are to be operated simultaneously in order to obtain data on methods of applying the water to the percolation areas, and particularly on the relative rates of percolation into ground, in its natural condition, when cleared of vegetation, and after the surface has been plowed.

CUSTOMS, REGULATIONS, AND LAWS RELATING TO IRRIGATION

During the year Technical Bulletin No. 254, Irrigation Districts, Their Organization, Operation, and Financing, was issued, superseding an earlier publication of similar title. The irrigation district has become the dominant type of irrigation organization in many sections of the West. It has been found, on the whole, better adapted to the improvement and extension of existing communities than to entirely new development. At the end of 1928, 407 such districts were actually operating and in that year supplied water to approximately 4,060,000 acres. Of the 398 districts that had issued bonds, 65 per cent had not failed in payment of principal or interest to the end of 1928. Of the bonds that had been sold up to that time, 71 per cent were then in good standing, but 18 months later the percentage had dropped to 67. Experience has shown that in determining the economic feasibility of enterprises prior to their financing

greater allowance should be made for unfavorable economic conditions during the period that the bonds will be retired.

A Summary of Irrigation-District Statutes of the Western States has been printed as Miscellaneous Publication No. 103, bringing together the provisions of the different States to permit comparison of the various requirements and obligations imposed and rights conferred.

FLOW OF WATER IN IRRIGATION CONDUITS

Hydraulic investigations of irrigation ditches and other conduits, the results of which have been made available in a series of department publications on flow of water in irrigation channels, wood-stave pipe, concrete pipe, and steel pipe have been continued this year. Measurements of the carrying capacities of certain flumes and tunnels have been made. The accuracy of the formulas developed from these studies gives them great value in designing irrigation conduits of sufficient size to carry the required quantities of water without wasting funds in constructing works larger than necessary. The collection of such data is being continued.

SEWAGE IRRIGATION

The study of sewage irrigation at Vineland, N. J., has been continued. The amount of sewage applied to the fields has been measured and samples are sent weekly to the laboratory of the New Jersey Agricultural Experiment Station for analysis to determine its fertilizer value. From the results of these analyses the approximate amounts of fertilizer applied to the fields may be determined. Water from wells at different points on the sewage farm has been analyzed bacteriologically and found unpolluted.

Experiments on the distribution of sewage have shown a system of underground terra-cotta pipes with concrete outlets located 3 feet apart to be superior to ditches as a distribution system. Application through furrows has proved best for very open soils, and application in alternate furrows appeared to be as efficient as application in every furrow, if not more efficient.

In order to compare the effects of irrigation with sewage and with well water, 1 acre has been equipped with overhead irrigation piping.

DRAINAGE INVESTIGATIONS

RUN-OFF AND DITCH CAPACITIES

The rainfall and run-off on nine watersheds in Ohio are being measured to determine drainage coefficients to be used in determining channel requirements. In eight of the channels values of n in Kutter's formula are being determined.

Some 30 stream-gagings were made, mostly of low-flow stages owing to the extensive drought. These low-stage measurements are of assistance in determining the trend of a series of phenomena extending from minimum to maximum flow. The division collaborated with the United States Geological Survey, which is making a study of minimum flow to determine water-power resources and sewage-disposal facilities.

The chief factors apparently influencing the concentration of the run-off are topography, rainfall intensity, and seasonal changes in soil and surface covering. A study has been in progress to determine whether there can be included in the run-off formula a factor which will be representative of the influences of topographic features alone. The rainfall is measured directly. The only unknown variable is, then, the seasonal change in soil and surface covering. Results of this study have been very encouraging but more intensive tests are needed, requiring very accurate rainfall measurements. To this end the standard rain gages have been replaced by automatic weighing and recording instruments. The automatic instruments not only afford a more accurate sample of rainfall intensities, but also permit a more exact determination of periods of concentration.

Experiments have been made on methods and costs of cleaning drainage ditches with dynamite and a report has been prepared.

The investigations of the run-off from the Ralston Creek watershed, Iowa, were continued and a report covering five years' work on this project is in preparation.

OPERATION AND MAINTENANCE OF DRAINAGE PUMPING PLANTS

Studies have been conducted for several years at pumping plants along the Illinois and Mississippi Rivers to determine the costs of pumping with different types of power and how such costs can be reduced. The manuscript for a department bulletin has been prepared. It has been found that the average costs of pumping with Diesel engines and with electric motors do not differ greatly. Many small and medium-sized steam plants, having been found inefficient, have been abandoned. Operating costs have been reduced by employing a competent engineer to supervise the operation of the plant; by properly regulating the speed of the pumps; by adjusting, cleaning, or repairing pumping equipment; and by installing more economical equipment. In some districts maintaining a lower water level in the suction bay would provide better drainage for the low lands.

A manuscript has also been prepared relating to the design and operation of pumping plants. The investigations have shown that screw-type impellers operate efficiently at low lifts, and that synchronous motor units with two motors on the shaft, direct-connected to the pump, operate efficiently.

Some promising experiments have been started on observation wells in one Illinois drainage district to determine the effect on the ground water of lowering the drainage water by pumping. In addition, on a number of plots a study is being made to determine the effect of different depths of the ground water table on crop yields.

HYDRAULIC EXPERIMENTS AT UNIVERSITY OF IOWA

The experiments on the obstruction of pile trestles to the flow of water, noted in previous annual reports, were completed during the year and a report on them prepared. It was found that a double-track pile trestle with the piles in line offered about twice as much resistance to flow as a single-track trestle. A double-track trestle with the bents offset offered a little more obstruction than a similar trestle with the bents in line. When a trestle crosses a stream

obliquely, bents set in echelon cause less backwater than bents set at right angles to the axis of the bridge.

The investigations of the obstruction of bridge piers to the flow of water were continued.

The Ramser silt-measuring apparatus in combination with a 2-foot Parshall measuring flume was calibrated in the hydraulic laboratory. Various modifications of the apparatus were tried. The apparatus was found to be sufficiently accurate from a hydraulic standpoint to warrant its use on the bureau's soil-erosion experiment farms.

DURABILITY OF DRAINTILE

The investigations at University Farm, Minn., on the durability of draitile under exposure to various conditions of soil and frost action have been continued, in cooperation with the Minnesota department of Agriculture and the Minnesota department of drainage and waters. The results of the studies relating to frost resistance of clay tile have been issued in a mimeographed report. These studies have made possible a general correlation between absorption and freezing tests of tile from various clay-tile plants in Minnesota and Iowa.

In the concrete-alkali work, 5-year tests have now been completed for 309 series of concrete specimens exposed to the action of sulphate water. Much of value has been learned about the use of certain admixtures in connection with curing temperatures only slightly higher than those used at commercial plants.

SOIL-EROSION CONTROL

Eight experiment farms have now been established where soil-erosion-control and moisture-conservation studies are being conducted in cooperation with the Bureau of Chemistry and Soils and the State agricultural experiment stations. These are located at Guthrie, Okla.; Temple and Tyler, Tex.; Bethany, Mo.; Hays, Kans.; Pullman, Wash.; Clarinda, Iowa; and Statesville, N. C.

On the soil-erosion experiment farm near Guthrie, Okla., it was found that from 3 to 24 inches of soil had been removed from a badly eroded and gullied area which has been under cultivation for about 30 years, as compared with no appreciable erosion on the virgin land. A careful record of crop yields from two comparable areas of virgin and badly eroded land showed a yield of 75 per cent more cotton on the virgin land, the average yields being 156 and 89 pounds per acre, respectively. At 14 cents a pound for cotton, there would be a difference of \$9.38 per acre in favor of the virgin land. The cost of constructing the terraces on the virgin land was about \$2.50 per acre and on the gullied land about \$14.50 per acre. These results demonstrate conclusively the advisability of starting the control of erosion when the land is first broken, rather than waiting until it has become badly gullied.

The effectiveness of terraces in controlling erosion is demonstrated by an experiment in which the soil losses from an unterraced and a level-terraced area were measured. As the result of a rain of 1.22 inches, 5.38 tons of soil per acre were lost from the unterraced area and only 0.21 ton per acre from the terraced area. The importance

of giving proper grades to the terraces is indicated by the fact that about three times as much soil was carried off the field by a terrace with a grade of 6 inches per 100 feet as by a terrace with a grade of 4 inches per 100 feet. Concerning the required height of terraces it was found, for terraces up to 700 feet long on ground having a slope of $5\frac{1}{2}$ per cent, that with vertical spacings of 2, $3\frac{1}{2}$, and 5 feet, heights of 12, 15, and 18 inches, respectively, were required to carry away the water from a fairly heavy rain.

Experience with level terraces having closed ends, designed to retain all of the rain that falls on the land above the terrace, indicates that this kind is not advisable for regions of high annual rainfall and for soils that can not absorb water rapidly. While level terraces have resulted in increases of 30 to 40 per cent in crop yields in west Texas and Oklahoma where the annual rainfall is light and the soil absorbs a large part of the rainfall, it was found on the Guthrie farm that an oat crop was decreased in yield nearly 60 per cent by water standing in the terrace channel.

It has been found that much of the tractor equipment now being manufactured is not sufficiently flexible to operate satisfactorily over terraces. The operation of several machines has been studied and suggestions made to the manufacturers for improving their equipment. The manufacturers realize that ultimately much of the land in the United States must be terraced and that their equipment must be designed to operate successfully over terraced land.

Data thus far obtained seem to indicate that the broad-base Mangum terrace can be constructed most economically by building from both sides on gentle slopes and from the upper side on steep slopes. It has also been found that where terraces are built from both sides the furrow below the terrace should be obliterated, otherwise this furrow fills with water after heavy rains, overflows at the low points, and thus causes the formation of small gullies down the slope between the terraces.

The use of large machinery designed for building and maintaining roads, borrowed without cost except for the labor and fuel required in its operation, has in many cases effected a considerable saving in the cost of building farm terraces. A recent statute in Oklahoma permits counties and townships to loan such equipment for this purpose, on the terms stated.

For check dams in small gullies experiments at the Guthrie farm indicate that a height of about 2 feet is most satisfactory from the standpoint of economy and successful operation; that some sort of anchorage is needed for brush dams, even where the gully has a very limited drainage area; that the sides of the gully above the dam should be protected against erosion; that the dam should not reduce the cross section of the gully so much as to cause overflowing of its banks; and that a more rapid filling above a brush dam occurs when care is taken to pack the brush closely so as to reduce the size of the interstices.

FARM MACHINERY INVESTIGATIONS

CORN-BORER CONTROL

Because of the drought during the corn-growing season of 1930, the regular spread and normal increase in intensity of the European

corn borer was considerably retarded. For the same reason stalk growth was stunted and much more fodder was cut for feed than ordinarily. Therefore, certain activities connected with the development and testing of corn-borer machinery were slowed up and others had to be postponed. Shredding and baling tests could not be conducted because of scarcity of stalks that even approximated normal growth, and heavily infested stalks were difficult to find. Nevertheless, considerable progress was made.

The high-pressure field burner developed in previous years for combating the European corn borer has been converted into a low-pressure burner, and the rigid hood has been replaced by a flexible hood in three sections to facilitate burning on uneven ground. Field tests in borer-infested fields showed this burner to effect a high mortality of the borers, but indicated that the initial and operating costs for the burner will be considerably greater than for other control machinery now available. No further work with burners is planned for the near future.

The 3-row stalk shaver attachment for a single-row corn cultivator, developed last year, has been reconstructed so as to fit each of six of the principal makes of cultivator. A similar attachment for cutting four rows was developed for two makes of 2-row cultivators.

The 4-bar, side-delivery rake was further improved. Field tests were conducted on experimental rakes made by three manufacturers. These rakes performed satisfactorily when tested in corn; they are still in the field for test in alfalfa, timothy hay, and soybeans. In order to cover two rows the reel on the side-rake stalk loader with 2-row shaver attachment had to be lengthened 2 feet. Plans are under way to change the angle of the reel so that two rows can be raked without lengthening the reel.

A down-stalk lifting-finger attachment was developed for corn binders, and probably can be made adaptable to other row-crop harvesters.

A 2-furrow, 21-inch plow was built at Toledo, Ohio, and performed very creditably on three different soil types. A floating trash shield, for scraping the stalks into the open furrow from part of the furrow slice as it is turned, promises to be an aid in clean plowing for borer control. Careful studies have been made of the characteristics affecting the draft of plows. Further draft tests will be made to determine the most important factors involved.

Cooperative work has been undertaken with most of the New England agricultural experiment stations and with those of Illinois and Pennsylvania. Headquarters for the New England work have been established at South Norwalk, Conn.

A new experimental farm has recently been acquired near Toledo, Ohio, which will be operated jointly with the Bureau of Entomology.

ARTIFICIAL DRYING OF FORAGE CROPS

In some of the Southern States a large variety of forage crops can be grown, but weather conditions during the harvest season cause improper curing and in some instances total loss of the crop. An experimental forage dryer has been installed on the Iberia Livestock Farm near Jeanerette, La., and tests are being made to determine some of the mechanical and economic factors involved in

artificial drying of such crops. Feeding tests were made with the artificially dried product to determine its nutrient value in comparison with field-cured forage. This project is being conducted in cooperation with the Bureaus of Animal Industry and Plant Industry.

DIRECT HARVESTING AND ARTIFICIAL DRYING OF RICE

The combined harvester-thresher has been used to a limited extent in harvesting rice in Arkansas, Louisiana, and Texas, but use of this machine has been successful only when accompanied by artificial drying of the threshed grain. The structure of the rice kernel is such that it may crack or rupture as a result, in part, of changes in temperature and moisture content. Tests were made during the 1930 harvest season to determine the maximum air temperature at which rice may be dried without injury to its milling properties. It was found that a temperature much in excess of 120° F. would cause appreciable injury. This work was conducted in cooperation with the grain division of the Bureau of Agricultural Economics.

SUGAR-BEET MACHINERY

The production of sugar beets involves much hard labor, under present practices, particularly in thinning the stand of young beets and in harvesting the crop, including removal of the tops before the beets are delivered to the sugar factory. The cost of these operations and the difficulties in seasonal employment of large amounts of labor have resulted in a demand from the growers for equipment that will reduce the labor requirements of this crop. Investigation of this subject was undertaken at the beginning of the fiscal year.

A blocking machine has been developed and tested in cooperation with the California and Colorado Agricultural Experiment Stations. The use of this implement has resulted in a saving of 25 per cent of the cost of hand labor in thinning beets. The three most distinctive types of beet harvesters also are being studied under field conditions in California and Colorado, in an effort to develop a more efficient machine for this purpose.

COTTON-PRODUCTION MACHINERY

The first year's work under this project has been of a preliminary nature, in analyzing the problems of cotton production with reference to the use of labor-saving machinery, in developing methods of research procedure, and in formulating plans for cooperative investigations. Projects have been established in cooperation with the Alabama and Mississippi experiment stations, dealing with methods of soil preparation, factors affecting planting and the final stand of cotton, methods of weed control, the use of labor-saving machinery, the control of large machine units on hillsides, and the efficiency of field machinery and mechanical cotton pickers.

Detailed research studies as to the factors affecting rolling resistance have been made with six wheels upon two soil types under different physical conditions. Definite correlations have been determined between the weight of wheel and the rolling resistance, the percentage of slip, and the depth to which the wheel sinks into the

soil. New correlations were made between the apparent specific gravity and moisture content of the soil and the rolling resistance of a wheel.

COTTON GINNING AND CONDITIONING

With funds appropriated by Congress for cotton ginning investigations, a cotton-ginning laboratory has been constructed and equipped at the Delta Branch Experiment Station, Stoneville, Miss. Cotton was first ginned at the laboratory in January, 1931. The studies there are for the purpose of improving cotton-ginning methods, and are carried on in cooperation with the Division of Cotton Marketing of the Bureau of Agricultural Economics. Several old cotton gins have been obtained, one built in 1844, and these will be used for purposes of comparison.

Approximately 1,000 tests were made during the year with cotton obtained from Georgia, Alabama, Mississippi, Missouri, and Texas. Complete soil and agronomic data were obtained for each lot of cotton. The tests covered various moisture conditions of the cotton, and various speeds of the saws from 300 to 1,000 revolutions per minute. Loose and tight rolls were obtained at each speed.

The tests so far indicate the necessity for a complete analysis of the fiber effects caused by present combinations of cleaners and extractors, and show the benefits to be derived from conditioning or drying seed cotton before it is ginned. Tests are being made to find a method of removing the green-leaf trash from cotton harvested with mechanical pickers.

A new type of cotton drier has been developed by the division for the use of growers who can not afford to buy the more expensive types. It has no moving parts and can be built at small expense.

MECHANICAL APPLICATION OF FERTILIZERS

Investigations of the mechanical application of fertilizers have been carried on cooperatively with the Bureau of Chemistry and Soils, the State experiment stations, the joint committee on fertilizer application, and the National Fertilizer Association.

Fertilizer-placement studies on cotton have been continued and expanded at the Pee Dee, Sandhill, and Clemson College experiment stations in South Carolina. Similar studies have been started in nine other representative cotton growing areas in the States of North Carolina, Georgia, Mississippi, Louisiana, Texas, Arkansas, and Oklahoma. The results to date indicate that highly significant differences in germination and yield result from different placements of the fertilizer in relation to the seed, when application is made at planting time. Disturbance of the soil below the seed in obtaining certain placements of the fertilizer is known to delay germination, particularly when rains do not immediately follow the planting. Irregular distribution of fertilizer gives somewhat lower yields than uniform distribution.

Cooperative fertilizer-placement studies have been started on canning crops, including sweet corn and beans, at Geneva, N. Y., and on potatoes in New Jersey, Ohio, and Michigan.

Two special machines for the fertilizer experimental work have been built under the general specifications of the division of agri-

cultural engineering. These machines apply the fertilizer and plant the seed simultaneously, giving accurate control of the application rate and placement of the fertilizer.

A laboratory in which the temperature and relative humidity of the air will be under control is under construction at Arlington Experiment Farm, Rosslyn, Va. The operation of various types of fertilizer distributors will be studied in the laboratory, and fundamental information will be obtained for use in the further development of distributing equipment.

FARM-LAND DEVELOPMENT

The experimental work on the use of poisons for killing trees and stumps was completed. The investigation brought out the fact that while many poisons may be used successfully for killing trees, arsenical poisons are most effective in hastening decay, and hence are best for use in land-clearing operations. Different species of trees show various degrees of resistance to the action of the poison; softwoods usually decay more rapidly than hardwoods. No sure method of killing stumps, effective on all species and under all conditions, was developed.

Methods of clearing land of brush and stones have been studied largely in cooperation with the University of Minnesota. A report has been prepared showing the comparative costs of clearing land on the four principal types of soil found in northern Minnesota. The data upon which this report is based were secured from records of operations carried on by 150 farmers and are given in sufficient detail to determine the number of man-hours and horse-hours, and the amount of explosives required for each operation involved in clearing and plowing land. Studies of soils producing heavy forest growth are being made to determine whether the crops that can be obtained from such soils are sufficiently larger than those from soil producing light timber to justify the greater cost of clearing the heavy timber.

The study in arranging farms for the most efficient production of crops, begun in 1930, has been continued. Each farm will be treated as a unit in which the cropping program, livestock, field arrangement, machinery, and buildings will all be properly coordinated. Co-operative projects along this line have been undertaken in North Carolina, Georgia, and Minnesota, and a number of farms have been surveyed in preparation for these studies. On 13 farms surveyed in North Carolina the average size of the field was 3.7 acres; on 20 farms in Georgia the average size was 5.6 acres; and on 11 farms in Minnesota the average size was 12.2 acres. The plans made for farms in North Carolina and Minnesota increase the average size of field to 10.8 and 28 acres, respectively. After the farmers have made the changes recommended, records will be kept to determine the increased income resulting.

FARM-STRUCTURE INVESTIGATIONS

SURVEY OF RESEARCH IN FARM STRUCTURES

This survey, for which the field work was nearly completed last year, made apparent the need for coordination of efforts. While

20 State experiment stations reported more than 50 projects as active, it seems that a large number of these are directed at securing comparative data on building problems in which there is a present and perhaps temporary interest. There has been a tendency toward duplication of effort in such phases of the field, while other phases equally or more important have been neglected. It appears that comparatively few accurate and basic data on the shelter factors which various farm buildings should furnish, or the best structural means of meeting those requirements, are being developed. Such information is needed to guide the judgment of owners and builders, who are continually striving to make new buildings more useful, economical, and convenient than those built previously.

The need for coordinated national and regional programs of research was made very evident. The State workers in this subject generally suggested that the Federal department take the lead in formulating such programs.

The report of the survey has been prepared for publication, and plans have been made for organization of all available agencies for effective conduct of the coordinated research program.

ORCHARD HEATERS

A preliminary study was made of the operation of oil-burning orchard heaters such as are in general use in California to prevent frost damage. The heaters tested were of the distilling type. This type produces smoke, particularly at high rates of combustion, and the clouds of smoke from large numbers of the heaters operating simultaneously is very objectionable to the aesthetic and economic interests of neighboring property owners. The object of the study was to determine the cause of excessive objectionable smoke arising from the heaters, and what preventive measures—such as proper selection of fuel or improvement in design of the heater—might be economically feasible. The data obtained have been analyzed and a report is in preparation.

CROP STORAGES

A study of the storage of corn and small grains in the Corn Belt was completed and a report prepared for publication. The need for increased facilities for farm storage has become important, because of economic changes in marketing and the growing use of machine harvesters. Structures satisfactory where hand husking is employed have proved inadequate in strength of buildings and in means of handling the crop with dispatch, when corn is harvested by machinery.

TEMPERATURES IN DAIRY BARNs

A study of the relation of stable air conditions to milk production was begun in cooperation with the Bureau of Dairying and with the agricultural college of the University of Wisconsin. The purpose is to determine the effect of sudden changes in stable temperatures on the production of milk by the cow of medium capacity, and the consequent necessity of insulation in the construction of dairy barns as a factor in temperature maintenance. The aim is also to determine the air conditions under which cows will produce the maximum

quantity of milk consistent with their health and comfort. The results of one season's observations are not considered conclusive, particularly as the winter was unusually mild, and the study is to be continued.

SERVICE WORK

The value of the services that have been rendered to other bureaus of the department is made evident by the greatly increasing demands for assistance of varied character. Work of this nature performed during the past year has included the preparation of plans and specifications as follows:

For the animal husbandry experiment farm at Beltsville, Md., a 3-story poultry laboratory building and a building for housing small animals employed in zoological investigations.

For the Arlington Experiment Farm at Rosslyn, Va., a combined drug-plant laboratory and storage building, a threshing shed, a building for experimental work on fertilizer machinery, and two headhouses.

For the Bureau of Plant Industry at Guayama, P. R., a laboratory and an office building.

For this bureau and the Bureau of Agricultural Economics, a cotton-ginning laboratory erected at the Delta Branch Experiment Station, Stoneville, Miss.

For the National Zoological Park, cold-storage rooms, remodeling of the general heating system, and an eagle flight cage.

For the extensible building of the department, now under construction; a refrigerating plant, vacuum pumps, air compressors, etc.

Also, specifications were prepared for a number of refrigerating, heating, plumbing, and electrical installations at field experiment stations of the Department of Agriculture, and plans for an equipment depot to be erected at Ogden, Utah, for the use of the Bureau of Public Roads in storing and caring for road-building equipment.

Designs for a cheese factory and three creameries were prepared for general distribution.

The division supervised the construction and preliminary operation of the Bear River Migratory-Bird Refuge established by the Bureau of Biological Survey in Box Elder County, Utah, which was nearing completion at the end of the fiscal year. It also supervised construction of a dam and irrigation layout constructed near Cheyenne, Wyo., for the Bureau of Plant Industry.

Service is being rendered to the Bureau of Biological Survey in collection and compilation of data on water rights acquired or to be acquired for the Malheur Lake Bird Refuge in Oregon; to the War Department in the appraisal of lands and acquisition of flowage rights for the Mississippi River flood-control project; and to the State Department in estimating damages that would be caused to lands along Kootenai River in Idaho by the construction of a proposed power development in British Columbia.

REPORT OF THE SOLICITOR

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SOLICITOR,
Washington, D. C., September 5, 1931.

SIR: I submit herewith report of the work of the Office of the Solicitor for the fiscal year ended June 30, 1931.

Respectfully,

ELTON L. MARSHALL, *Solicitor.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

In the legal work of the office during the year there was a large increase, a substantial part of which may be attributed to the enforcement of the perishable agricultural commodities act of June 10, 1930 (46 Stat. 531), which has been actively administered. Under this law, hearings upon complaints filed with the department by interested parties are held at places where the respondents are engaged in business. These hearings are conducted by attorneys from this office, who review the evidence presented, prepare findings of fact, opinions, conclusions, and orders, and give advice on the many legal questions necessarily involved. So great has been the volume of work devolving on the office from this activity that it was found necessary to appoint two additional attorneys, in order that the work might not only be properly, but expeditiously, handled. Likewise, it necessitated the appointment of two additional stenographers, since the hearings are stenographically reported. In addition to the hearings already held, many cases are now under consideration in which future hearings will be ordered, and the number of violations of this recently enacted law, thus far called to the department's attention, indicates very clearly that the legal work arising thereunder in the future will be exceedingly heavy.

The office work was also greatly increased in volume because of the necessity for furnishing legal services in connection with the administration by the department of the joint resolution of December 20, 1930 (46 Stat. 1032) for the relief of farmers in the drought and storm-stricken areas of the country. This resolution carried an appropriation of \$45,000,000 for making loans to farmers and the amendment thereto of February 14, 1931 (46 Stat. 1160), appropriated an additional sum of \$20,000,000 for the purpose of forming agricultural credit corporations and like organizations and of assisting those already in existence, and for furthering agricultural rehabilitation in the drought areas. In addition to the foregoing, the

act of February 23, 1931 (46 Stat, 1276), appropriated \$2,000,000 to enable the Secretary of Agriculture to make loans to farmers in the States of Alabama, North Carolina, South Carolina, Georgia, and Florida, who suffered storm and/or drought losses to crops in 1929 and 1930, thereby making a total appropriation of \$67,000,000 for distribution by the department in such relief undertaking. For the purpose of aiding the administrative officials in making proper and prompt distributions under these appropriations, attorneys from this office were assigned to duty in seed-loan offices established in Memphis, Tenn., St. Louis, Mo., Grand Forks, N. Dak., Fort Worth, Tex., and Washington, D. C. It developed that such assignment greatly facilitated handling of the large volume of work connected with the making of seed loans. Under the personal supervision of these attorneys, mortgages and crop liens were prepared and other papers approved as to legality in 381,637 cases, where direct loans were made to individual farmers amounting in all to \$46,823,175. They also gave advice and rendered numerous opinions on the many legal questions arising in the prosecution of this work.

Considerable time has been devoted to the presentation and prosecution in the courts of much of the more important litigation in which this department is interested and it may be said that our efforts in this line have been conspicuously successful. Included in such litigation and noteworthy, is the case of *R. L. Phillips v. Arthur A. Wood*, forest supervisor, in which the plaintiff filed a bill in equity in the District Court of the United States for the Western District of North Carolina, asserting title to approximately 5,000 acres of land, located in the Nantahala National Forest, N. C. The bill sought to have declared void the title of the United States to said land claimed under old State grants from North Carolina to E. B. Olmstead. Plaintiff alleged his title thereto was derived from older grants by said State to W. H. Herbert and sought to have the title adjudged in him, and asked that the defendant as forest supervisor be enjoined from exercising dominion and control thereover, and from interfering in anywise with plaintiff's use or possession thereof. The Government defended upon the ground that plaintiff's predecessor in title had been divested of the title under the older grants to Herbert by an old judgment and execution had thereon, rendered by the court of common pleas and quarter sessions of Alamance County, N. C., in 1867. A further defense was that plaintiff could not maintain this suit on the equity side of the court, as his remedy, if any, was by a suit in ejectment, on the law side of the court. After a lengthy trial, the district court adjudged the title in plaintiff and granted the injunction as prayed, upon the ground that there was no sufficient record evidencing a judgment divesting plaintiff's predecessor in title under the senior grants and that, therefore, plaintiff's title was superior to that of the United States. The decree of the district court was appealed to the Circuit Court of Appeals for the Fourth Circuit, which reversed the judgment of the lower court and remanded the case to said court, with directions to require the plaintiff to amend his pleadings and proceed at law by way of ejectment, thus sustaining one of the defenses interposed by the Government. The case is still pending such further action as may be taken by the plaintiff in conformity with the appellate court's

judgment. In continuing this litigation as an ejectment suit, plaintiff will have the burden of proving a superior title. Moreover in thus proceeding he will be obliged to recognize and plead the fact that the Government at the present time is in possession of the land in controversy. Since this possession has continued over a period more than sufficient under the law of North Carolina to sustain a claim of title in the Government by adverse possession, plaintiff is in a less advantageous position than heretofore in contesting the Government's title.

Another important suit involving a dispute of Government title to lands in the national forests resulted in a decree favorable to the Government. In this case, entitled *Sutherland, et al., v. Wood*, forest supervisor, plaintiffs filed a bill in equity in the United States District Court for the Western District of North Carolina, claiming title to certain lands in the Nantahala National Forests, seeking to have the title of the United States in said lands declared void, and to enjoin the forest supervisor from exercising dominion and control thereover and from interfering with plaintiff's alleged rights of ownership therein. The title of the United States to these lands was derived from a series of grants from the State of North Carolina, in 1867, to this same E. B. Olmstead, based upon entries made by one James Taylor. Taylor, in his lifetime, disputed the legality of the issues of the grants to Olmstead upon the ground that he had never assigned his rights of entry to Olmstead, notwithstanding a recital to that effect endorsed on the back of the grants. The Olmstead title was long controverted by Taylor and those who claimed under him. Plaintiffs, in this action, claim to have derived title from Taylor and others associated with them under a subsequent grant from the State of North Carolina based upon a resurvey of his entry. This later grant overlaps the original grants to Olmstead under which the United States claims title. It was claimed by plaintiffs that the Olmstead grants were void for lack of definite location, and that the subsequent Taylor grant under which they claim gave them paramount title to the overlapping lands in controversy. The issue in the case turned largely upon the location of the beginning corner of the hinging grant of the series of Olmstead grants. The landmark fixing the beginning corner of the hinging Olmstead grant and described in the original Taylor entry as a "white oak," had disappeared and the burden was on the Government to show the location point where the white oak stood. The case was by direction of the court tried to a jury for an advisory finding of the facts in issue. The jury found that the location of the beginning corner of the hinging Olmstead grant was as contended for by the Government and as it appeared on a map of survey made in 1915 by Denman, examiner of surveys of the Forest Service. This finding was adopted by the court and a decree accordingly entered establishing title in the United States to the lands in controversy and definitely fixing the beginning corner of the hinging Olmstead grant at the point designated upon the Denman map. Plaintiffs appealed from this decree to the Circuit Court of Appeals for the Fourth Circuit, but the appeal was subsequently abandoned. The decree of the district court has thus become final and puts an end to a long-drawn-out controversy over the validity of the Olmstead grants involved in this suit.

In the case of Patterson, Boardman, and Knapp *v.* The Secretary of Agriculture, the Director of Regulatory Work, the Chief of the New York station of the Food and Drugs Administration, and the collector of customs at New York, the plaintiffs, who are New York egg importers, brought a bill for injunction, in the District Court of the United States for the Southern District of New York, to restrain the application of the so-called acid test prescribed by the department's regulations under the food and drugs act, for the determination of decomposition in dried-egg products. Plaintiffs claimed that this test was arbitrary, unfair, and inaccurate and that it was insufficient to sustain the rejection of importations of dried-egg products which did not comply therewith.

On motion of the defendants, the bill was dismissed as to the Secretary of Agriculture and the Director of Regulatory Work, upon the ground of lack of personal jurisdiction of the court over these officials. The bill was retained as to the other defendants who challenged the sufficiency of the bill to state a cause of action by a motion to dismiss, which was heard and argued and overruled by the court. Thereupon, these defendants filed an answer denying that the test was arbitrary or inaccurate. The plaintiffs then filed a motion for a temporary injunction to restrain the application of the test to plaintiffs' importations of dried-egg product and further detention of their importations of this product which did not conform to the test. This motion was argued and briefs were submitted to the court by both plaintiffs and defendants. Decision upon the motion is still pending.

In the case of Bianchi & Co. *v.* The Secretary of Agriculture and the Chief of the Bureau of Public Roads, mentioned in a previous annual report, wherein the Supreme Court of the District of Columbia dismissed plaintiff's bill and sustained the Secretary's authority to withhold approval, in his discretion, of contracts for Federal-aid projects to which the plaintiff would be a party until the plaintiff had made an adjustment with the State of Maine for defective work under previous contracts with that State, an appeal was taken to the Court of Appeals of the District of Columbia which was subsequently abandoned and a proper adjustment was made with the State of Maine, as required by the Secretary in the first place.

In the case of National Remedy Co. *v.* the Secretary of Agriculture, and the Director of Regulatory Work, plaintiff appealed from a judgment dismissing its bill for injunction brought to restrain multiple seizures under the food and drugs act of its medicinal preparation, known as B. & M. External Remedy, to the Court of Appeals of the District of Columbia. The appellate court, in a recent decision, reversed the favorable judgment of the lower court and remanded the case to the court below for further proceedings. In its opinion the court held that the allegations of the bill, if true, stated a cause of action for injunction, in that the making of multiple seizures, under the circumstances disclosed by the bill of complaint, was an arbitrary action by the department and calculated to deprive plaintiff of its property without due process of law. The department, believing that the decision of the court of appeals in the premises is erroneous, is endeavoring to have a review of the case by the supreme court.

In a prior fiscal year there had been initiated a program of basic determination, under the packers and stockyards act of 1921, of the reasonableness of the rates being charged by stockyard owners and market agencies at the principal terminal livestock markets of the country. In the preceding year the first phase of this program, i. e., the preliminary survey and study, had been completed and the second phase, namely, the holding of formal hearings, had been entered upon. Holding of hearings continued throughout the fiscal year 1931, with as active an intensity as was possible with the limited personnel available therefor. The hearing as to the reasonableness of stockyard rates at Kansas City, Mo., which had begun in the closing days of the preceding year, continued to conclusion during approximately the first six weeks of this year. Other hearings of equal importance were held at Kansas City, Mo. (with respect to market-agency rates), National Stockyards, Ill. (in regard to stockyard rates), and St. Joseph, Mo. (concerning the rates of market agencies). Through the stockyards involved in this particular program of rate hearings and determinations flows much of the national commerce in livestock. For example, in the calendar year 1930, there passed through the 10 stockyards 53,256,743 meat animals which originated in a territory comprising practically all the States west of the Mississippi River and many east thereof and which had a market value of hundreds of millions of dollars. The properties used by the stockyard owners in handling these animals aggregate many millions of dollars in value, that at St. Joseph, Mo., having been found by the Secretary of Agriculture to be worth \$3,382,148 and that at Kansas City, Mo., being variously estimated at from \$10,000,000 to \$30,000,000. Most of the livestock passing through the stockyards is handled by the market agencies, representing either the seller or the buyer and the value of livestock throughout the country is based upon the prices made in transactions in which the market agencies bargain for one side or the other. Each stockyard property has to be valued in the manner customary in valuation proceedings and much basic information has to be gathered relative to income and expenditures, trade territory, and the condition and future prospects of livestock therein, probable volume of business at the stockyard in the immediate future, fair rate of return on the investment, reserves and surpluses necessary against depreciation, and other contingencies. The determination of fair market-agency rates consists of group rate making for businesses which very largely are of a personal-service nature. It presents even more difficulty than is encountered with respect to the stockyard rates, for, while the determination of the latter represents an application to the particular business of principles mapped out in respect to other public utilities, the ascertainment of reasonable market-agency rates represents pioneering in the uncharted field of group rate making for personal-service businesses. In its importance and difficulty, the work is comparable with that of any rate-regulatory body in the country. The gathering of the necessary information is accomplished by the Bureau of Animal Industry, with the cooperation and advice of this office, but there devolves upon this office the responsibility of introducing it into the records in such a way that it will be recognized by the courts as evidence in the legal sense. To this end,

two attorneys of this office are assigned to each hearing, one to preside, under the designation of examiner, the other to act as chief counsel in the presentation of the evidence and later to argue the matter before the Secretary of Agriculture. Necessarily, many complex legal problems are met in the course of this work, and their correct solution requires the expenditure of much effort and study by the attorneys of this office.

Among the trade-practice cases under the packers and stockyards act of 1921, the so-called boycott case at St. Louis is of special interest. The National Order Buying Co., which had started in business on the St. Louis Stock Yards on or about August 5, 1930, informed the Secretary of Agriculture shortly thereafter that practically all of the "old-line commission agencies" and one cooperative agency had refused to sell hogs to it. The National Order Buying Co. is a cooperative order-buying organization, a small fraction of its stock being owned by the St. Louis Producers Commission Association, which is a cooperative sales agency. The old-line order buyers refused to buy from the Producers Association. Upon an investigation of this situation the Secretary issued an inquiry and notice of hearing charging boycotting by these parties in violation of the act. It was further alleged not only that the commission merchants had individually violated the act by engaging in the unfair practice of refusing to show, offer for sale, or sell livestock held by them for sale on behalf of shippers, but also that the order buyers had individually engaged in the unfair practice of refusing to buy or make offers for livestock held for sale by the cooperative agency. The hearing on this complaint began November 6, 1930, and continued about three weeks. The case was argued before the Secretary on December 19 following. After careful consideration of the entire record, including the argument, an order was issued by the Secretary February 24, 1931, suspending for 90 days the registration of all the respondents, except a few as to whom the charges were dismissed, and directing them to cease and desist from the unfair and discriminatory practices charged in the notice of inquiry. Upon the issuance of the Secretary's order, the respondents filed a petition in the United States District Court to restrain the Secretary from enforcing the order. On March 21, 1931, the case was heard by a statutory court of three judges at Danville, Ill. The court temporarily set aside the suspensions but upheld the rest of the order with the proviso that the respondents carry on business relations with the boycotted agencies in the usual course of business. The case has been set down for argument on its merits on September 14, 1931.

Our cordial relations with the officials of the Department of Justice in Washington and with the United States attorneys throughout the country have continued and have been mutually helpful and effective. Considerable assistance was rendered to the United States attorneys by the practice of this office in preparing and submitting the complaints in 28-hour law violations and, when practicable, the libels in food and drug cases, as well as indictments and information in nearly all the criminal cases reported for prosecution under the regulatory laws of the department. Petitions for condemnation of lands under the Weeks forestry law and other acts were also prepared in this office and transmitted to the various United States attorneys for use in the conduct of condemnation proceedings. Preparation of these plead-

ings greatly facilitated the handling of the department's litigation by the United States attorneys.

The work of the office has been conducted economically and expeditiously during the fiscal year, and there follows a statistical summary of that part of the work.

Three hundred and fifteen written opinions were rendered to administrative officials of the department. No record was kept of the advice given these officials in daily informal consultations, nor of opinions briefly expressed in writing on papers sent to this office for consideration.

One thousand two hundred and thirty-two notices of judgment were prepared for publication, pursuant to authority contained in the food and drugs, insecticides, naval stores, and Federal seeds acts.

In addition to the criminal prosecutions hereinafter tabulated, 1,441 decrees of condemnation and forfeiture were entered under the food and drugs act, 19 under the insecticide act, 1 under the Federal caustic poison act, and 10 under the Federal seed act.

There were reported to the Attorney General 2,790 violations of statutes entrusted to the department for enforcement.

Table 1 shows the several statutes under which these violations were recorded and the amounts of fines and recoveries in cases settled with and without contest.

TABLE 1.—*Cases reported, fines imposed, and judgments recovered, fiscal year 1931*

Laws involved	Number of cases	Fines and recoveries	Laws involved	Number of cases	Fines and recoveries
National forest laws.....	198	\$48, 278. 62	Naval stores act.....	2	\$300. 00
Food and drugs act.....	59	12, 041. 00	Produce agency act.....	1	250. 00
Migratory-bird treaty act.....	239	5, 295. 02	Federal seed act.....	1	200. 00
28-hour law.....	227	22, 800. 00	Upper Mississippi River wild life and fish refuge act.....	9	365. 00
Meat inspection act.....	26	1, 767. 00	Standard container acts.....	3	125. 00
Plant quarantine act.....	41	1, 711. 00	Farm products inspection law.....	1	100. 00
Animal quarantine acts.....	41	4, 735. 00			
Insecticide act.....	3	160. 00	Total.....	859	98, 187. 64
Section 84, penal code.....	8	60. 00			

TABLE 2.—*Contracts and leases prepared or examined, fiscal year 1930*

Bureau, division, or office	Contracts	Leases	Total
Forest Service.....	2, 243	31	2, 274
Biological Survey.....	1	7	8
Agricultural Economics.....	8	100	108
Animal Industry.....	6	48	54
Chemistry and Soils.....	4	3	7
Dairy Industry.....	11	-----	11
Entomology.....	9	30	39
Plant Industry.....	31	48	79
Public Roads.....	7	28	35
Real estate officer.....	2	10	12
Federal seed loans.....	2	3	5
Food and Drug Administration.....	8	4	12
Grain Futures Administration.....	1	4	5
Personnel and Business Administration.....	8	-----	8
Plant Quarantine and Control Administration.....	10	48	58
Weather Bureau.....	41	46	87
Total.....	2, 392	410	2, 812

In addition to the items listed in Table 2, there were submitted for examination as to sufficiency of form and execution numerous contracts prepared by the various bureaus and by individuals and corporations.

During the year 50 bonds, and 425 renewals and 35 terminations of leases and contracts, were prepared. In addition to the examination of the above tabulated contracts and the bonds connected therewith, for sufficiency as to execution, there were examined for sufficiency of form and execution 353 cooperative agreements with State experiment stations and others covering experimental work of various kinds. There were also examined 103 bonds of indemnity covering advances under the subsistence expense act of 1926, and the act of June 3, 1902; 3,119 Federal-aid project agreements and 1,396 modifications of such agreements and 11 Federal warehouse bonds.

Five hundred and ten certifications of papers, records, and bulletins of the department were prepared at the request of litigants, for use as evidence by them in court proceedings.

Thirty claims of balances due estates of deceased employees were examined, necessary papers were prepared for their payment, and advice was given to administrative officials on matters relating thereto.

Twenty-two employees of the department were arrested while in the performance of their official duties for alleged violations of the traffic regulations and were represented at the hearings and trials by attorneys in this office. A case of particular interest to the department occurred when one of its drivers, while engaged in delivering lumber in the department grounds for use in construction of temporary quarters for the 4-H club, was arrested by a traffic officer on a charge of violating the traffic regulations. The case was tried. It was contended, as a matter of defense, that the Secretary of Agriculture had sole jurisdiction over that part of the area known as Reservation No. 2, which constitutes the Department of Agriculture grounds, and that any employee of the department, while attending to official business of the department in those grounds, was not subject to arrest for violation of the traffic regulations, as the walks and roadways, although used by the public, were constructed primarily for department activities and that the public was only entitled to use same, so as not to interfere with department activities. This contention was upheld by the court and the case was dismissed.

Eighty-three claims involving damages to privately owned property resulting from the alleged negligence of employees of the department, while engaged in the performance of their official duties, were considered under the act of December 28, 1922, and advice given with respect thereto.

Fifty miscellaneous cases covering claims for damages arising out of automobile accidents for the recovery of money due the United States were referred to the Department of Justice. In several instances, payments of claims were secured from individuals and corporations without litigation as a result of correspondence conducted with them by this office. Four of these cases were closed during the year.

During the year, two bankruptcy claims were prepared and filed on behalf of the department against bankrupt firms. Consideration and advice were also given in 20 personnel cases, looking to disciplinary action against the employees involved.

Attorneys in the office attended, or participated in, public hearings accorded the trade relative to amendments of the regulations under the United States grain standards act and in a number of hearings held under the packers and stockyards act of 1921, as well as hearings pertaining to the other activities of the department. Many conferences were attended on matters relating to the plant quarantine, United States warehouse, standard container, perishable agricultural commodities and national forest laws. Frequent conferences were held with attorneys and others interested in seizure and criminal cases pending in the Federal courts under the food and drugs act and the insecticide and fungicide act, and numerous conferences were also had with attorneys and others on legal matters in connection with the various other regulatory laws.

Regulations issued by the Secretary under the various statutes committed to the department for administration were prepared or assistance was given in their preparation. Among the more important of these were regulations governing the administration of the perishable agricultural commodities act and the enforcement of the farm products inspection law, the United States warehouse act and the United States cotton futures act. Assistance was also given to the preparation of many amendments to regulations issued under various regulatory laws. Many proclamations, forms, specifications, and schedules required in the enforcement of the regulatory laws were also prepared. Orders governing the interstate movement of plants and livestock, grain inspection, cotton standards, and the fiscal administration of the department were also prepared, revised, or reviewed. Statements of issues, briefs, and memoranda on other legal matters were prepared at the request of the officials of the department for submission to the Attorney General, the Secretary of the Interior, and the Comptroller General. Numerous service and regulatory announcements, circulars, and bulletins of the various bureaus as well as contract forms prepared by the States for use in connection with Federal-aid road work were referred to this office for consideration from a legal aspect and were reviewed and commented upon.

Many bills for various purposes, referred to the department for comment by committees of Congress, were examined and assistance was rendered in the preparation of reports thereon. Among the bills so considered were the following: S. 4408, a bill to provide for standard methods of grading and valuing cottonseed; S. 5106, to provide for advances by Federal land banks to certain borrowers therefrom; H. R. 10345, to provide for the collection and publication of statistics for peanuts; H. R. 11329, to prevent deceit and unfair prices resulting from the unrevealed presence of substitutes for virgin wool in woven or knitted fabrics purporting to contain wool and in garments or articles of apparel made therefrom, manufactured in any territories of the United States or the District of Columbia or transported or intended to be transported in interstate or foreign commerce, and providing penalties for violation of its provisions; H. R. 12479, to coordinate the agricultural experiment station work and to extend the benefits of certain acts of Congress to the Territory of Porto Rico; S. 2801, authorizing and directing the Secretary of Agriculture to investigate all phases of taxation in relation to agriculture; and H. R. 6909, to provide for the control of

soil erosion, prevent the silting of navigable waterways, preserve and replenish underground sources of streams, perpetuate water resources, and reduce losses through drought.

Assistance was given in the preparation of a bill to amend certain sections of the United States warehouse act, of a bill to authorize the Secretary of Agriculture to carry out his 10-year cooperative program for the eradication, suppression, or bringing under control of predatory and other wild animals injurious to agriculture, horticulture, forestry, animal husbandry, wild game, and other interests, and for the suppression of rabies and tularemia in predatory or other wild animals and for other purposes, and of a bill to amend the provisions of the Federal caustic poison act so as to make it include within its provisions two substances, bensol and toluene.

Briefs and memoranda on legal questions involved in many of the cases reported to the Attorney General for prosecution were prepared and furnished and assistance was also given the United States Attorneys in the trial of some of the cases. Among the more important of these were: *United States v. B. & M. External Remedy*; *United States v. Capon Spring Water*; *United States v. Lee's Save the Baby*; *United States v. 100 cases, cull figs, et al.*; *United States v. Crisp's Black Tongue Remedy*, *Crisp's Distemperte*, *Crisp's Tung-Tone*, and *Crisp's Hot Shot* (these four combined for purposes of trial); *United States v. Ten cases of Bred Spred*; *United States v. Certain quantities of "4-44"*; *United States v. 7 packages of Harris Roach Tabs*; *United States v. Certain quantities of Whitlock's U-Gar-gl*; *United States v. Robert Damus and Harry Buttnick, individuals, and Buttnick Mfg. Co. and Puget Sound Salmon Canning Co., corporations*; and *Patterson, Boardman & Knapp v. Joseph Callaway, jr., et al.*; all involving prosecutions and suits arising under the food and drugs act.

THE NATIONAL FORESTS

There were handled 207 claims for lands within the national forests which were initiated under the public land laws of the United States. Decisions were rendered on 87 of these claims, of which 79 were favorable to the Government and 8 were unfavorable. Attorneys of this office participated in the trials of 30 court cases and represented the Government before the United States local land offices in 26 hearings. There were handled also 198 cases of trespass on property of the United States on the national forests. Oral advice was frequently given and numerous written opinions relating to the administration of the national forests were submitted. There were prepared or passed upon for legal sufficiency 1,681 legal papers of various kinds.

Work for the Forest Service during the fiscal year, other than under the Weeks forestry law, included handling the following cases and other business:

Claims to land pending during year.....	207
Hearings attended.....	26
Briefs prepared and filed.....	25
General litigation and settlement.....	35
Contracts, leases, bonds, etc.....	1, 482
Bills, complaints, information, protests, etc.....	124
Abstracts of title examined.....	28

Court appearances.....	30
Written opinions.....	301
Stipulations.....	15
Trespasses (for damages and fines collected, see Table 3) :	
Grazing.....	34
Timber.....	29
Fire.....	102
Property.....	7
Occupancy.....	26

TABLE 3.—*Trespass cases on the national forests in which damages and fines were recovered, fiscal year 1931*

Character of trespass	Number	Damages	Fines
Grazing.....	26	\$2, 512. 29	\$160. 00
Timber.....	21	2, 826. 77	75. 00
Fire.....	64	40, 688. 56	705. 00
Property.....	2		186. 00
Occupancy.....	2	1, 125. 00	
Total.....	115	47, 152. 62	1, 126. 00

CASES OF INTEREST

Protection to forest officers against criminal prosecution by county officials for killing horses branded as well as unbranded when found to be grazing on national forests in violation of an order of the Secretary of Agriculture is assured by the decision of Federal Judge Jacobs of the United States District Court for Arizona granting a permanent injunction against the county attorney and the sheriff of Navajo County. An order had been issued by the Secretary closing to grazing certain areas on the Sitgreaves National Forest and directing the forest officers to dispose of all wild horses found on the area after a specified date. The county officers contended that the order did not apply to branded horses and that the killing of such was in violation of State law. They therefore declared that they would arrest every officer killing branded horses. The court held that wild horses within the order are undomesticated animals or domesticated animals living in a wild state. The court also held that a horse of unknown ownership is one of which the ownership is not known to the officer executing the order and the ownership of which can not be ascertained by the exercise of due diligence. It is believed that this, and previous decisions, in favor of the Government will insure compliance with closing orders and discourage further litigation of the question.

That land in a game sanctuary within a national forest is not subject to mineral location was held by the Federal Court for South Dakota in a suit involving the validity of the Rushmore lode mining claim which was located two years after the creation of the Custer Park Game Sanctuary in the Harney National Forest. The locators were Fred Hazeltine and Roy Alexander and the latter had taken possession of an old cabin and planted a garden, apparently intending to use the land for residential purposes. This interfered with the administration of the national forest and was also objectionable to the Mount Rushmore Memorial Association, since the cabin adjoined the Rushmore Highway used to a large extent by persons visiting the park. The court enjoined the claimants from going upon the land

or interfering in any way with the administration of the national forest and the game preserve.

Mining claimants may not inclose large areas of national forest land not necessary to enable them properly to carry on their mining operations. This was decided by the United States District Court for Arizona in a suit brought by the Government to restrain Max Baumkirchner from inclosing an area of about 2,000 acres of national-forest land within the Coronado National Forest covered by mining laws but desired for grazing purposes rather than mining developments. The case is of special interest, because it is the first in which the court has enjoined the mere inclosing of mining claims, whereas in all other instances the injunctions have been directed against the carrying on of business not connected with mining.

The United States Circuit Court of Appeals, at San Francisco, in the case of the United States *v.* Tujunga Water & Power Co., 48 Fed. (2d) 689, held that a grantee of an easement for a reservoir under the irrigation right of way act of March 3, 1891, must construct the reservoir according to the representations made in its application in order to obtain the benefits of the act. The Tujunga Co. in its application for a right of way within the Angeles National Forest, had represented that it would construct a dam 115 feet high which would make a reservoir covering 93 acres. The dam actually built did not rise above the level of the stream it obstructed and was evidently intended merely to check the underground flow of percolating waters. The district court had held that the company had substantially complied with the representations in the application but its decision was reversed by the circuit court of appeals.

Damages in the sum of \$9,312.60 on account of a forest fire on Charlie Creek in the St. Joe National Forest were awarded the Government against the Blackwell Lumber Co. by the United States District Court at Boise, Idaho. This sum covers the cost of fighting the fire and the value of the young growth destroyed. The case is of special interest, because the value of the young growth was reached by the cost of protecting the areas until the stand is restored. General negligence was alleged because of the failure of the company to prevent the spread of the fire to Government land in the national forest. A further allegation of special negligence was made, in that the company failed to pile and burn its slashings concurrently with the cutting of trees along the logging railroad, failed to dispose of slashings on horse trails and rollways concurrently with cutting timber at these places, and operated an oil-burning locomotive without a spark arrester. A charge of negligence was also based upon failure to comply with the Idaho law relating to brush on logging-railroads rights of way. The court upheld the principle that it is the duty of the Government to protect its property and that it is not obliged to wait for private owners to act before doing so.

WEEKS FORESTRY LAW

(36 Stat. 961)

The National Forest Reservation Commission during the year authorized the acquisition of 799 tracts of land, aggregating 527,661 acres, in 36 purchase areas, including the recently established forests in the States of Mississippi, Oklahoma, and Vermont. There were

examined and closed 780 acquisitions, aggregating 598,089.48 acres, which resulted in the payment of \$1,872 271.98 purchase money to the grantors. In addition to such purchases, there were examined and closed 5 exchanges of land, amounting to 508 acres. The acreage added to the national forests during the year from these acquisitions totaled 598,597 acres. Titles to lands in excess of 700,000 acres were examined. In connection with the work involved in these acquisitions there were prepared 751 agreements of purchase.

Due to defects in titles, 27 offerings aggregating 66,479.65 acres have been acquired through condemnation proceedings instituted in the United States district courts, and similar suits were instituted which are now pending, for the acquisition of 138 offerings, aggregating 51,727.69 acres.

In order to afford financial aid to the drought-stricken regions, special attention was given to acquisitions in forests within or adjacent to drought areas, and title examinations, in connection with such purchases, were accelerated to the fullest extent. Speeding up the work for such purpose resulted in the completion of more title work during the year than has been accomplished in this project in any previous year. Details of the work performed under this law are set forth in Table 4.

TABLE 4.—Operations under the Weeks forestry law and the Clarke-McNary law, fiscal year 1931

State	Area acquired	Area in condemnation	Area authorized for purchase	State	Area acquired	Area in condemnation	Area authorized for purchase
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>		<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Alabama.....	1,076.99		10,016	South Carolina...	3,330.00		1,603
Arkansas.....	36,760.81	6,052.56	48,787	Tennessee.....	2,771.31	7,240.44	13,875
Florida.....	112,944.87	18,171.86	32,104	Vermont.....			31,228
Georgia.....	14,489.30	7,516.74	67,465	Virginia.....	5,286.97	5,654.02	12,334
Louisiana.....	57,370.00		19,182	West Virginia...	39,644.90	667.08	16,710
Maine.....			264	Michigan.....	75,661.92		121,606
Mississippi.....			63,147	Minnesota.....	47,679.36		8,898
New Hampshire...	22,038.48		18,117	Wisconsin.....	94,777.49		127,130
North Carolina...	3,490.56	4,076.94	57,180				
Oklahoma.....	48,097.15		8,516	Total.....	598,089.48	51,727.69	681,033
Pennsylvania.....	32,669.37	2,308.05	22,871				

FOOD AND DRUGS ACT

(34 Stat. 768)

At the beginning of the fiscal year there were pending in the courts 353 cases under the Federal food and drugs act, of which 45 were criminal and 308 were civil. During the year there were reported to the Department of Justice 96 criminal cases, involving 498 violations, and 1,591 civil cases, a total of 1,687 cases in all. There were thus pending, during the year, 141 criminal and 1,899 civil cases, making a total of 2,040 cases in all. There were terminated, during the year 70 criminal and 1,566 civil cases, a total of 1,636, leaving 71 criminal and 333 civil cases, or a total of 404 cases, pending at the close of the fiscal year.

In 59 of the criminal cases terminated, as shown in Table 5, fines were imposed, 51 after pleas of guilty, 6 on pleas of *nolo contendere*,

and 2 after jury trials in which verdicts returned in favor of the Government. Ten cases were nolle-prossed, or dismissed and the statute of limitations barred the filing of the information in one case. Two of the dismissals represent cases in which the jury found the defendants not guilty.

Of the 1,566 civil cases terminated, 1,045 were terminated by default decrees, 396 by consent decrees, and 125 cases were dismissed, chiefly because no seizure of the goods had been effected.

One thousand two hundred notices of judgments were prepared and published during the year.

TABLE 5.—*Fines imposed in criminal cases (exclusive of costs, which were generally assessed) under the foods and drugs act, fiscal year 1931*

Number of cases	Amount of fine	Total	Number of cases	Amount of fine	Total
1	\$1	\$1	2	\$200	\$400
1	5	5	1	225	225
3	10	30	1	250	250
1	20	20	6	300	1,800
14	25	350	1	350	350
1	30	30	1	450	450
4	50	200	4	500	2,000
1	60	60	2	1,000	2,000
1	75	75	1	800	1,600
8	100	800	1	300	600
1	140	140			
1	140	140			
2	150	300			
1	175	175			
1	180	180			
			Total (59 cases)		12,041

¹ Against 2 as individuals and 2 as corporations; 2 individuals fined \$800 each; 2 corporations fined \$300 each.

CASES OF INTEREST

On appeal in the case of the United States *v.* Ten Cases, more or less, of Bred Spred, the Circuit Court of Appeals for the Eighth Circuit affirmed the judgment of the lower court in directing a verdict in favor of the claimant. The main contention of the Government before the appellate court was that the trial court erred in not allowing the case to go to the jury on the question of the adulteration and misbranding of the article involved. The Government's conception of the adulteration provision in question was that it was necessary only to show that the article, Bred Spred, is inferior to what it appears to be or is represented to be and that the article had been mixed in a manner whereby such inferiority is concealed, and the Government's proof, at the trial of the case, was directed to that end. With respect to misbranding, the position was taken that there could be a misbranding even in the absence of false or misleading statements on the label, if the article is an imitation of another article. The appellate court, in maintaining that there was a failure of proof, interpreted the adulteration provision as requiring proof that Bred Spred was a damaged or an inferior food product, because one or more of its constituents was damaged or inferior and because it was mixed in a manner whereby the inferiority, by comparison with some other article, was concealed. Regarding the error assigned to the view taken by the trial court that there was no statement on the labeling of Bred Spred that was not true and therefore no misbranding, the appellate court held that there could be no reversal on the

record before it, even conceding the construction contended for by the Government, principally on the ground that physical exhibits of Bred Spred and jars of jam, which were in evidence at the trial, had not been brought before it. Motion for a rehearing, so that the exhibits might be brought before the court, was denied and the Department of Justice declined to petition the Supreme Court for a writ of certiorari to review the case.

The case of *United States v. Robert Damus and Harry Buttnick*, individuals, and *Buttnick Manufacturing Co. and Puget Sound Salmon Canning Co.*, corporations, was based on a criminal information containing four counts, three of which charged the defendants with the interstate shipment of adulterated salmon, and the fourth alleged the interstate shipment of misbranded salmon. None of the counts alleged prior conviction. At the trial in the District Court for the Western District of Washington, the jurisdictional facts having been stipulated, the Government proved that the salmon in question was rotten and decomposed to the extent of from 45 to 60 per cent. The sales and shipments involved in this case were a joint enterprise, each of the defendants having a property interest in the salmon, except Damus, who was a broker negotiating the sale and, in that capacity, looking after the shipment to the purchaser. Damus attempted to defend upon the ground that as a broker he was liable for the shipment. The other defendants claimed an absolute sale of the salmon to Damus before shipment. Still another defense was that the salmon shipped was reconditioned from another seizure and had been released as fit by the Federal food authorities. The proof did not, however, satisfactorily establish the last defense. The case was submitted to the jury on the theory that the sales and shipments of this salmon were a joint enterprise and that if the product shipped was adulterated and misbranded as charged all defendants were liable. The jury returned a verdict in favor of the Government. On the theory that, since the statute does not expressly stipulate that heavier penalties for subsequent offenses apply only when the latter are preceded by a conviction, heavier penalties are due for subsequent offenses, even though no previous conviction is pleaded or proved, the court fined each of the defendants and, in addition, ordered Damus and Buttnick committed to imprisonment for three and seven months, respectively, on the basis that the first count alleged a shipment on a date prior to the dates of those alleged in the remaining counts, the information thus alleging subsequent offenses. This action of the court was over objection of Government counsel, who contended that jail sentences for first offenses under the statute were invalid. Defendants moved for a new trial on the grounds that the instructions to the jury were unfair and prejudicial and the sentences excessive and illegal. The motions were denied as not being the proper remedy. However, the court accepted the view that imprisonment under the penalty provisions of the food and drugs act could not legally be imposed in the absence of a prior conviction and ordered the defendants to appear for resentencing, at which time fines only were imposed.

The case of *Chichester Chemical Co. v. United States* was an appeal brought by claimant to the Court of Appeals of the District of Columbia from a judgment in favor of the Government in a

proceeding under the food and drugs act to condemn an interstate shipment of the claimant's pills which were charged by the Government as being misbranded in violation of the Sherley amendment to the food and drug act. At the trial claimant offered in evidence certain letters between the company and its counsel, for the purpose of showing its good faith in making the statements which the Government charged were false and fraudulent. On objection of Government counsel that these letters contained self-serving declarations, the trial court refused to admit them in evidence and its ruling in this respect constituted the principal question before the appellate court. In its opinion, the court of appeals inclined to the view that the doctrine of self-serving declarations, in the absence of any evidence that the rejected letters were written for the purpose of making a case, or in anticipation of a prosecution, was not applicable to a situation where, as in the instant case, it was incumbent upon the Government to show an actual intent to deceive in making the curative or therapeutic representations complained of.

The case of *United States v. 2,200 Cases of Cull Figs*, tried in the District Court for the Northern District of California, is the first case ever to go to trial in which the proviso in section 2 of the food and drugs act had been invoked. That proviso exempts an article from the other provisions of the act "when intended for export to any foreign country and prepared or packed according to the specifications or directions of the foreign purchaser when no substance is used in the preparation or packing thereof in conflict with the laws of the foreign country to which said article is intended to be shipped * * *." The figs in question were libeled on the grounds that they were wormy, moldy, unfit for human consumption, and were being offered for export to a foreign country, namely, Austria. The answer of claimant admitted that the figs when seized were unfit for human consumption but alleged that the foreign purchaser ordered and desired this particular quality and condition of cull figs and "that the exportation of said cull figs in their present condition to Austria is not in conflict with any of the laws of said country." Before proceeding to trial, the Government interposed a motion for judgment on the pleadings and, in addition, demurred generally to the answer, contending, in support thereof, that the proviso in section 2 did not exempt from the other provisions of the act an article of food which was wormy and moldy such as the figs in question were alleged to be. The Government took the position that the language of the proviso was intended only to apply to the use of preservatives in preparing and packing articles for export, and cited legislative history bearing out this interpretation of the language. The motion and demurrer were severally denied and overruled, to which action of the court the Government noted an exception. Thereupon the case proceeded to a hearing on the merits before the court sitting without a jury and the Government, in addition to proving the jurisdictional facts, adduced evidence showing that the figs were infested with live and dead worms and the larvæ of worms, as well as being moldy and dirty. Claimant offered testimony of only one witness who testified that the figs offered for export were in response to an order for cull figs; that he was familiar with the foreign purchaser's business; and that he knew that, after processing,

the figs were to be packed and sold as a coffee substitute. In rebuttal, the Government introduced in evidence a certified copy of a regulation of the Austrian Government which provided in effect that coffee substitutes must be free from mold, insects and their mites. At the close of the case, the Government moved for judgment, which motion was denied and an exception allowed the Government. The court found in favor of the claimant and entered findings of fact and conclusions of law, to the which exceptions were also noted.

The case of *United States v. Rawleigh's Rheumatic Tablets*, in the District Court for the District of Colorado, was a seizure proceeding against an interstate shipment of the tablets whose labeling represented the preparation as efficacious in the treatment of rheumatism. The libel charged that the article was misbranded within the meaning of section 8, paragraph 3, in the case of drugs, in that certain statements contained on the bottle labels and in the accompanying circulars regarding the curative or therapeutic effects of the preparation were false and fraudulent. Claimant excepted to the libel on the grounds, (1) that the libel was not verified, (2) that no seizure of the goods had been made prior to the filing of the libel, and (3) that no notice and preliminary hearing had been afforded the claimant prior to the institution of the libel. On argument, the first exception was not pressed and the second was decided in favor of the Government. As to the third exception, the court inclined to the view that such a notice and hearing should have been afforded but expressed a hesitancy to dismiss the libel in view of the holding in *United States v. Morgan*, 222 U. S. 274, where the Supreme Court held that a hearing before the department was not a condition precedent to the filing of a criminal prosecution under the food and drugs act. Suggestion was made by the court that the claimant should withdraw its answer and the case be allowed to stand until the preliminary hearing was granted. The Government persisted in its contention that a preliminary hearing is not a condition precedent to the existence of a cause of action, and the court dismissed the libel. To this action of the court the Government excepted, and the Attorney General has under consideration the department's request that this case be appealed to the Circuit Court of Appeals for the Tenth Circuit.

The Government's motion for rehearing in the case of *United States v. Shreveport Grain & Elevator Co.*, in the District Court for the Western District of Louisiana, was granted and, after reargument, the court (J. Dawkins) adhered to the position previously taken that paragraph 3 of section 8 of the food and drugs act, the so-called net-weight amendment, was unconstitutional as in violation of the sixth amendment, for the reason that it is too indefinite and uncertain and sets up no ascertainable standard of guilt.

The case of *United States v. Lee's Save the Baby* was tried to the District Court for the District of Connecticut, Judge Thomas sitting without a jury. The labeling of the preparation *Lee's Save the Baby* recommended the article "For Croup, Tonsillitis, Bronchitis, Sore Throat, Influenza, Grippe and Pneumonia." The libel charged that these representations were statements concerning the curative or therapeutic effect of the article and constituted a misbranding within the meaning of paragraph 3, in the case of drugs, of section 8 of the

food and drugs act and that, while so misbranded, the article was shipped in interstate commerce. Claimant's answer joined issue on all the essential allegations of the libel. It was the Government's contention that the labels represented that the preparation, if used as directed, would exert a curative tendency on the diseases mentioned and it adduced evidence to show that the preparation would, in fact, exert no curative tendency whatsoever, but would merely act as a soothing agent tending to make the patient feel more comfortable. The claimant's witnesses agreed with those of the Government as to the preparation being a soothing agent or palliative but went further to say that in soothing the patient—making him more comfortable—he is being put in a better position to combat the disease. It was the claimant's contention that the labels represented merely that the preparation, if used as directed, would be beneficial in the treatment of the diseases mentioned and that they contained no representation that the preparation would exert a curative tendency in any disease; that since the Government's own witnesses testified to its beneficial effects, there could therefore be no misbranding. The court found that the preparation had curative properties in the diseases mentioned and entered a decree ordering the goods returned to the claimant. The department has recommended that an appeal be taken from the judgment in this case.

The cases of *United States of America v. Crisp's Tung-Tone*, *Crisp's Distemperte* and *Crisp's Black Tongue Remedy*, Food and Drugs 23777 and *United States of America v. Crisp's Hot Shot*, Food and Drugs 24068, were combined for the purposes of trial before the District Court for the Eastern District of Louisiana. Thus, for the first time, four separate and distinct preparations were tried at the same time to one jury. The libel in the former case charged that *Crisp's Tung-Tone* was misbranded within the meaning of paragraph 3 of section 8 of the food and drugs act, in that the preparation was represented by its labels as a preventive for the disease, black tongue, in dogs, whereas it was, in fact, nothing more than a cathartic, having no properties which would tend to prevent such disease. It also charged that the preparation *Black Tongue Remedy* was misbranded in that it was represented by its labels as being a cure for the disease, black tongue, in dogs, whereas, in fact, it was merely an antacid and a cathartic and had no properties which would tend to bring about a recovery from the disease. The libel further charged that the preparation *Crisp's Distemperte* was misbranded in that it was represented by its labels as a cure for distemper in dogs, when, in fact, it had no properties which would tend to bring about a recovery from the disease distemper. The libel in the last case charged that the preparation *Crisp's Hot Shot* was misbranded in that it was represented by its labels as having curative properties for running fits in dogs, whereas, in fact, it consisted merely of a mild cathartic together with one dose of a worm expeller and was wholly inadequate as a treatment for any of the disease conditions which bring about running fits. The labeling of *Crisp's Black Tongue Remedy* recommended not only the use of the preparation but also recommended feeding the dog salmon, fresh eggs, and milk during the course of treatment. It was the Government's contention that any favorable result that may apparently have been obtained from the use of the remedy was due to the use of the feeding of this particular diet and

that no benefit was obtained from the administration of the remedy. At the trial, the Government offered the testimony of a number of eminent qualified witnesses in the field of veterinary medicine to show that the disease black tongue is brought about as a result of a deficient diet which can be prevented or cured only by proper diet and that no drug or combination of drugs is capable of supplying this deficiency. It was further shown that the disease distemper is a disease of the respiratory tract which must run its normal course and can not be affected by alleged internal antiseptics. The Government further proved by expert testimony that running fits are not in and of themselves a disease but are a symptom of a considerable number of diseases and that the veterinary medical profession knows of no single combination of drugs which would be an adequate treatment for all of the disease conditions which may bring about running fits.

Furthermore, the Government showed that full information concerning all of these diseases was available to the claimant from many sources including textbooks on veterinary medicine, bulletins issued by the Public Health Service, and pamphlets put out by the Bureau of Animal Industry of the Department of Agriculture. The claimant relied largely upon the testimony of a number of lay witnesses who testified to having used the remedies in question with satisfactory results. It was shown on cross-examination, however, that, where the preparation Tung-Tone was concerned, the dogs had been receiving adequate diet and would probably not have developed black tongue had the preparation Tung-Tone not been used as a preventive. Where Black Tongue Remedy was concerned, it was shown that the witnesses had followed directions and fed the diet of salmon, fresh eggs, and milk, thus bringing about the recovery by supplying the deficiency in the dogs' diet. Where Distemperte was concerned, it was shown in the cases where the remedy was used that the percentage of mortality was equal to the normal mortality rate in the disease distemper, thus negating any peculiar results obtained from the use of the preparation Distemperte. Where Hot Shot was concerned, it was shown that this is a disease which has a very low rate of mortality and that recovery from the disease is usually to be expected.

In charging the jury, the court issued the following instructions among others:

Now again reverting to the issues in the case, the Government contends that these products contain no ingredients or combination of ingredients capable of producing the effects claimed for them and that the claims that are made for them are false and fraudulent and were applied by the manufacturer knowingly and in disregard of their truth or falsity, so as to falsely and fraudulently represent to the purchasers and create in their minds the impression and belief that the articles were in whole or in part composed of or contained ingredients effective in the diseases mentioned in the cartons and circulars or in the prevention thereof.

In this connection I charge you that the words false and fraudulent as used in the statute must be taken in their accepted legal meaning and that before you will be justified in finding for the libelant it must be found that the statements contained in the labels or circulars were put there to accompany their goods with actual intent to deceive—an intent which may be derived from the facts and circumstances but which must be established. It was the claimant's duty, however, to make such investigation as was necessary to enable him honestly to make statements concerning the curative or therapeutic effect of his preparations. If he did not do this, and he says that he did, but acted with such gross carelessness and indifference to the truth of the representations contained in the statements as to warrant the conclusion that he acted

fraudulently, you are at liberty to so find, and in that event, should return a verdict that the drugs are misbranded.

After a brief deliberation, the jury found all four preparations to be misbranded as charged in the libels and decrees of condemnation and forfeiture were accordingly entered.

THE INSECTICIDE ACT OF 1910

(36 Stat. 331)

Twenty-one cases were reported to the Attorney General during the fiscal year, in five of which, involving 13 violations, criminal proceedings were recommended. Sixteen seizure (civil) cases were also reported during the year. At the close of the previous fiscal year, 28 cases were pending, 19 of which were criminal prosecutions, and 9 of which were seizure cases.

Fifteen of the cases pending at the close of the previous fiscal year, and 15 of the cases reported during the present year, aggregating 30 cases, were terminated. Of the cases so terminated, 8 were criminal and 22 were seizure. Fines were imposed in 3 of the criminal cases, in each of which a plea of guilty was entered. Four criminal cases were dropped or dismissed and, in one case, a court verdict of not guilty was rendered.

Sixteen of the seizure cases were terminated upon default decrees of condemnation, forfeiture, and destruction of the goods; 2 consent decrees were entered and the goods were taken down under bond; in 1 contested case, the court rendered a verdict and judgment for the Government followed by destruction of the goods; and 3 cases were dropped or dismissed.

The fines imposed in the three criminal cases referred to were \$75 in each of two cases and \$10 in the remaining one, the aggregate of the fines being \$160.

Thirty notices of judgment were prepared and published under section 4 of the act.

MEAT INSPECTION ACT

(34 Stat. 1260)

Twenty-nine cases, representing 38 violations, were reported to the Attorney General for prosecution under the meat inspection law during the year. Of these cases and the 35 cases pending in the district courts at the beginning of the year, convictions were had in 27, resulting in the sentencing of one defendant to a term in jail and in the assessment of fines shown in Table 6 below. In one case sentence was suspended on probation for 1 year.

TABLE 6.—*Fines imposed in meat-inspection cases, fiscal year 1931*

Number of cases	Fine in each	Total fines	Number of cases	Fine in each	Total fines
1-----	\$300	\$300	1-----	\$5	\$5
9-----	100	900	2-----	1	2
10-----	50	500			
2-----	25	50	Total (26 cases)-----		1,767
1-----	10	10			

During the year 11 cases were dropped or dismissed and, in one case, the grand jury returned "no bill." Verdicts of not guilty were returned in two cases.

On July 1, 1931, 13 cases which had been reported prior to July 1, 1930, and 10 cases reported during the fiscal year were still pending, making a total of 23 cases still pending on July 1, 1931.

VIRUS SERUM TOXIN ACT

(37 Stat. 833)

Advice was given to administrative officers on various legal questions arising in connection with the enforcement of this statute.

NAVAL STORES ACT

(42 Stat. 1430)

Two criminal cases were pending at the beginning of the year. One case involving four violations was prepared and referred to the Attorney General during the year for prosecution. These three cases were terminated, one by dismissal, the other two by the entry of pleas of guilty and nolo contendere by the defendants, who were fined \$200 and \$100, respectively.

One notice of judgment was prepared and published during the year.

Opinions, both formal and informal, upon various legal matters arising in the administration of this statute were rendered to administrative officials.

FEDERAL SEED ACT

(37 Stat. 506)

At the beginning of the fiscal year there were two criminal cases pending under the Federal seed act. During the year there were reported to the Attorney General 2 criminal and 12 seizure cases, a total of 14 in all. Three of the criminal cases were terminated, one on a plea of nolo contendere and the imposition of a fine of \$200, while in the other two indictments were not returned before the running of the statute of limitations. Ten of the seizure cases reported were terminated, six by the entry of consent decrees of condemnation and forfeiture and release of the goods under bond and three by the entry of default decrees ordering the goods destroyed. The libel in the one case remaining was dismissed because the goods were not available for seizure. There were thus pending at the close of the year one criminal and two seizure cases.

FEDERAL CAUSTIC POISON ACT

(44 Stat. 1406)

One seizure case was reported to the Attorney General involving an article misbranded under the Federal caustic poison act. This case was terminated by the entry of a default decree ordering the goods destroyed.

Opinions, both formal and informal, upon questions arising in the course of the administration of the statute were rendered to interested officials.

Under the authority granted in the statute, one notice of judgment was prepared and published.

FEDERAL IMPORT MILK ACT

(44 Stat. 1101)

Advice was given to the administrative officers on various legal problems arising in connection with the enforcement of this statute.

PLANT QUARANTINE ACT

(37 Stat. 315)

Prosecutions were instituted under the plant quarantine act in 37 cases during the year, either through the Attorney General or by United States Attorneys on information furnished by the department. Of these 30 were closed by the imposition of fines, 1 by suspending sentence without imposition of fine, and 1 by dismissal. At the close of the fiscal year 1930 there were 16 cases pending, 11 of which were closed during this year by the imposition of fines, 1 was dismissed, and sentence suspended in 1, without imposition of fine. Details of the fines imposed in the enforcement of this act are shown in Table 7.

TABLE 7.—*Fines imposed in plant quarantine cases*

Number of cases	Amount of fine	Total	Number of cases	Amount of fine	Total
1.....	\$1	\$1	10.....	\$50	\$500
2.....	5	10	1.....	60	60
5.....	10	50	1.....	75	75
2.....	15	30	2.....	100	200
3.....	20	60	1.....	150	150
9.....	25	225	1.....	250	250
2.....	30	60			
1.....	40	40	Total (41 cases).....		1,711

There were 8 cases pending at the close of the year, of which 3 were pending at the beginning of the year and 5 were instituted during the year. Thirteen written opinions were given on legal questions raised by the Plant Quarantine and Control Administration, and many verbal opinions were given in conference with members of the administration. Conferences were also had with the Plant Quarantine and Control Administration with reference to the revision of quarantines or of the regulations thereunder in connection with quarantine No. 43, on account of the European corn borer; No. 48, on account of the Japanese beetle; No. 68, on account of the Mediterranean fruit fly (three times during the year); No. 52, on account of the pink bollworm; No. 53, on account of the satin moth; No. 38, on account of the black stem rust; and No. 45, on account of the gypsy moth and browntail moth. Conferences were also had in connection with the revision of foreign quarantine No. 37, covering the importation of nursery stock, plants, and seeds, and in connection with the revision of the rules and regulations governing the movement of plants and plant products into and out of the District of Columbia.

FEDERAL HIGHWAY ACT

(42 Stat. 212)

During the fiscal year 617 original and 82 revised project statements for Federal-aid road projects approved by the department were first reviewed to determine whether they were eligible under the law. The amount of Federal aid which will be allocated for these projects has not yet been determined, as under the project statement form, now used a project covers the whole route involved between given control points, and the Federal aid is only requested and allocated as each section of the project is reached for actual construction. Project statements for nine such projects disapproved by the department during the fiscal year were similarly reviewed.

During the fiscal year 2,148 project agreements and certificates of approval of plans, specifications, and estimates, prepared by the Bureau of Public Roads, were reviewed as to their form and sufficiency of execution by the State highway departments, and were submitted to the Secretary and executed by him. Drafts of 1,246 modifications of project agreements and certificates of approval, prepared by the Bureau of Public Roads for execution by the State highway departments and the Secretary, were similarly reviewed. These project agreements, together with the increases provided by the modifications of agreements, involved a total estimated cost of \$326,026,453.95 and Federal aid in the amount of \$150,806,098.05. They involved also the original improvements with Federal aid of 10,506.8 miles of road and additional improvements of 4,146.7 miles of road. In addition to the foregoing, project substitutions to the number of 65 were reviewed during the fiscal year and were approved by the Secretary.

There were also reviewed as to form, substance, and sufficiency of execution 188 original contracts for the construction of roads within or partly within the national forests. There were similarly reviewed 117 cooperative agreements between the department and cooperating agencies for constructing roads within or partly within national forests.

Project of statements for 37 flood-relief projects and 34 original and 3 modified agreements for flood-relief projects were reviewed as to form, substance, and sufficiency of execution on the part of the States and recommended for approval by the Secretary of Agriculture. These flood-relief projects involved 116,194 miles of road and \$2,751,994.01 as the Federal share of the cost of their construction, including reimbursements for work already performed and for which project papers were not required.

The department also approved during the fiscal year 23 project statements for Federal-lands highway projects under the act of June 24, 1930 (46 Stat. 805), each of which was first reviewed to determine whether it was eligible under the law. There also were six original project agreements for Federal-lands highway projects which were reviewed as to form, substance, and sufficiency of execution on the part of the States and recommended for approval by the Secretary of Agriculture. These Federal-lands highway project agreements involved 31.27 miles of road and \$423,856.60 as the Federal share of the estimated cost of the construction.

CASE OF INTEREST

In accordance with section 23 (b) of the Federal highway act, the Secretary of Agriculture on December 5, 1930, entered into a cooperative agreement with the board of supervisors of Apache County, Ariz., under which they were to procure certain portions of the right of way for section 1 of the realigned Clifton-Springerville Highway and to maintain the highway, beginning two years after its completion. H. G. Udall and wife, owners of some of the land needed for the relocated road, brought suit in February, 1931, to enjoin the carrying out of this contract and, on May 1, 1931, the court overruled the defendants' (supervisors') demurrer and perpetually enjoined them from carrying out the contract. On appeal, the court overruled the supervisors' motion for a new trial and judgment was entered April 11, 1931.

It was felt that this decision, if allowed to stand, would bring to an end practically all Federal-aid road construction under section 23 of the act in the 12 counties of Arizona having national forests, because, in all such cases, when forest roads are built, private lands occur along the route of the construction work and it is usually the county that undertakes to procure the necessary rights of way, by condemnation or otherwise. Because of this fact, and of the importance of the question involved, the justices of the Supreme Court were prevailed upon to apply special procedure thereto and decide the case upon the briefs without oral argument. At the close of the fiscal year, no decision had been rendered.

**ACTS RELATING TO THE INTERSTATE MOVEMENT OF LIVESTOCK
FROM QUARANTINED DISTRICTS, PROHIBITING THE INTER-
STATE MOVEMENT OF DISEASED LIVESTOCK**

(23 Stat. 31; 26 Stat. 414; 32 Stat. 791; 33 Stat. 1264)

Eleven cases involving violations of the act of May 29, 1884 (23 Stat. 31), were reported to the Attorney General for prosecution, of which 4 were terminated by fines of \$100 each, 1 by a fine of \$200, and 1 by the entry of an order of nolle prosequi. Of the cases pending at the close of the preceding fiscal year, 7 were terminated by fines of \$100 each and 1 by the entry of an order of nolle prosequi. There were 7 cases pending at the close of the fiscal year.

Twenty-eight cases, comprising 30 counts, were reported to the Attorney General for prosecution under the act of February 2, 1903 (37 Stat. 791), of which 1 was terminated by a fine of \$25, 10 by fines of \$100 each, 2 (1 of which comprised 2 counts) by fines of \$200 each, and 1 by a verdict of not guilty. Of the 43 cases comprising 48 counts pending at the close of the preceding fiscal year, 12 were terminated by fines of \$100 each, 1 by a fine of \$200, 1 (comprising 2 counts) by a fine of \$500 and sentence to 5 months' imprisonment, 3 (of which 1 comprised 2 counts and 1 comprised 3 counts) by sentence of 3 months' imprisonment each, 1 by a verdict of not guilty, 1 by the refusal of the Grand Jury to return an indictment, 2 by dismissal, and 1 by the entry of an order of nolle prosequi. Thirty-five cases, comprising 37 counts, were pending at the close of the year.

Two cases were reported to the Attorney General for prosecution under the act of March 3, 1905 (33 Stat. 1264), both of which

were terminated by sentences of imprisonment for one year in jail. Of the cases pending at the close of the preceding year, 1 was terminated by a fine of \$10, 1 by a fine of \$100, and 2 by the entry of orders of nolle prosequi. Two cases were pending at the close of the year.

In all, 41 cases under the animal quarantine laws were reported to the Attorney General during the year, and 44 cases were pending at the close thereof. Details of the fines imposed in the enforcement of these laws are shown in Table 8.

In those instances in which it is stated that a jail sentence was imposed under those laws, the sentences were probated for varying periods.

TABLE 8.—*Cases under animal quarantine laws disposed of by the imposition of fines*

Number of cases	Fines	Total
1.....	\$10	\$10
1.....	25	25
34.....	100	3,400
4.....	200	800
1.....	500	500
Total (41 cases).....		4,735

Regulations governing the shipment of livestock from tuberculosis free accredited areas (B. A. I. No. 324), governing the recognition of breeds and purebred animals (B. A. I. Order 325), declaring the names of countries affected with foot-and-mouth disease (B. A. I. Order 326), governing the movement of livestock between the United States of America and the United Mexican States (B. A. I. Order 327), and governing the appraisalment of, and compensation for, tuberculous and paratuberculous cattle condemned and destroyed in the control and eradication of tuberculosis and paratuberculosis of animals (B. A. I. Order 329), were reviewed, as were also other orders issued by the department in connection with the administration of these laws.

Ten bonds to insure the handling, in accordance with the regulations of this department, of hides and skins imported from foreign countries were examined during the fiscal year.

In four instances, where suit had been brought against employees of the Bureau of Animal Industry, conferences have been had with, and memoranda have been prepared for, the Department of Justice setting forth the facts to show that the suit was based on some act performed in the course of official duty and, in each instance, a United States attorney has been directed to appear, and has appeared, in behalf of such employee.

TWENTY- EIGHT HOUR LAW

(34 Stat. 607)

One hundred and eighty-six cases were reported to the Attorney General under the 28-hour law. Penalties aggregating \$22,800 were recovered in 227 cases (as shown in Table 9), and 11 cases were dismissed. At the close of the year, 225 cases were pending.

TABLE 9.—*Penalties assessed under the 28-hour law*

	Number of cases	Penalty	Total
226.....		\$100	\$22, 600
1.....		200	200
Total (227 cases).....			22, 800

AGRICULTURAL COLLEGES, EXPERIMENT STATIONS, AND EXTENSION WORK ACTS

(24 Stat. 440; 34 Stat. 696; 45 Stat. 571; 38 Stat. 372; 45 Stat. 711)

Written opinions were given with reference to the following matters: The applicability of Government telegraph rates to messages sent by Extension Service employees and paid for out of State funds; the transfer, in accordance with the agricultural appropriation act of 1932, to the Alaska Agricultural College of certain lands used by the department as a Federal experiment station; the allotment of the additional extension work funds, provided for in the second deficiency act of July 3, 1930; the necessity of appropriations by the legislature of the State of Washington, in order that funds provided by the Federal experiment station and extension service acts might be available in this State; as to whether the act of March 4, 1931, bringing Porto Rico within the scope of the Smith-Lever and Capper-Ketcham Acts, authorizes a permanent annual increase of \$50,000 in the Extension Service funds available for that territory; whether greenhouses might be purchased for the use of the experiment station in Hawaii; and as to the legality of the proposed cooperative agreement with the University of Hawaii and several private organizations in that Territory for the formation of a graduate school of research in agricultural science at the university.

MIGRATORY BIRD TREATY ACT

(140 Stat. 755)

Four hundred and thirty-nine cases were reported to the Attorney General under the migratory bird treaty act and fines were imposed in 239 cases, as shown in Table 10.

TABLE 10.—*Fines imposed under the migratory bird treaty act*

Number of cases	Amount of fine	Total	Number of cases	Amount of fine	Total
2.....	\$0. 01	\$0. 02	1.....	\$65. 00	\$65. 00
10.....	1. 00	10. 00	11.....	100. 00	1, 100. 00
50.....	5. 00	250. 00	1.....	140. 00	140. 00
71.....	10. 00	710. 00	1.....	150. 00	150. 00
15.....	15. 00	225. 00	1.....	250. 00	250. 00
6.....	20. 00	120. 00			
49.....	25. 00	1, 225. 00	Total (239 cases).....		5, 295. 02
21.....	50. 00	1, 050. 00			

In 12 cases defendants were sentenced to jail or to the custody of United States marshals for terms ranging from 9 days to 6 months; 12 resulted in acquittal; 122 were either dismissed or nolle prossed;

and in 5, no bills were returned. One defendant was placed on probation for a year; while, in 10 cases, sentences were suspended for 5 years and, in another, a suspended sentence was given.

BIRD AND ANIMAL RESERVATION TRESPASS LAW

(Sec. 84 of the Penal Code)

Sixteen new cases were reported to the Attorney General under section 84 of the Penal Code. Of the cases so reported, and of those pending at the close of the previous year, 8 were terminated, 5 by fines of \$5 each, 2 by fines of \$10 each, and 1 by a fine of \$15, amounting, in all, to \$60.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE ACT

(43 Stat. 650)

Seven cases, involving violations of the upper Mississippi River wild life and fish refuge act, were prepared and reported to the Attorney General for prosecution. Of these, including previously pending cases, 13 were closed. Three were terminated by dismissal, 9 by fines totaling \$365, and 1 by suspended sentence.

Titles to 9,918.27 acres of land, involving 77 tracts, were examined and acquired by the United States by direct purchase under this law during the year. There were also acquired by decrees in condemnation proceedings 884.66 additional acres. The major portion of title work was completed as to 2,121.53 acres involved in eight other condemnation proceedings. Title examinations were made in seven other cases involving 791.45 acres, which are now under consideration for approval in the Department of Justice. There remain pending 128 title cases, in which the greater portion of the title work has been completed. In these condemnation proceedings, the United States attorneys for the districts in which the lands lie have charge of the proceedings but this office has charge of the title investigations, drafts the petitions and decrees, attends all hearings, and aids the United States attorneys in Illinois, Iowa, Minnesota, and Wisconsin.

More than 51 purchase and lease agreements were considered, and either approved or modifications suggested. Numerous questions have arisen in connection with the administration of the refuge, and in connection with surveys, on which legal opinions have been given to administrative officials.

MIGRATORY BIRD CONSERVATION ACT

(45 Stat. 1222)

During the year titles to 13,982.57 acres of land in Jefferson, Taylor, and Wakulla Counties, Fla., were examined and reported to the Attorney General. Of this acreage, 12,820.27 acres have been vested in the United States by direct purchase and 1,162.30 acres remain to be acquired, when title defects have been cured. In addition, titles have been partially examined to 25,769.53 acres in Charleston County, S. C., and titles to 8,982.12 acres in Imperial County, Calif., have been examined and reported to the Attorney General. The examination of titles to 38,998.72 acres in Garden County, Nebr.,

has been completed and is ready to be reported to the Attorney General. The title to 5,245.38 acres in Wakulla County, Fla., has been examined in the General Land Office at Washington, but the examination in Wakulla County has not yet been undertaken. The title to 11,778.40 acres in Hyde County, N. C., has been partially examined and that of 9,594.72 acres in Churchill County, Nev., has been requested, but not begun. The status of 5,180.40 acres in Alamosa County, Colo., has been studied and legislation drafted to facilitate its acquisition.

Many legal opinions have been given on the various questions which have arisen in connection with the negotiations for lands and the making of leases and purchase agreements in the administration of this law.

MALHEUR LAKE RESERVATION

(46 Stat. 1552, 1562)

This reservation was established by Executive order in 1908, subject to existing legal rights, and it became necessary to ascertain such rights as they existed in all claimants within the area. The perimeter of the surveyed lines purporting to show Malheur and Harney Lakes and the intervening waters is estimated at approximately 100 miles. The titles to lands averaging more than a mile in depth, adjacent to, but outside of, these survey lines, have been examined in the General Land Office at Washington, but the title examination in Harney County has only begun. It is estimated that more than 65,000 acres outside the meander lines will be covered by this examination to ascertain the claims of alleged riparian owners. The entire files leading up to the patents have been studied and copies have been obtained for evidentiary purposes. Extensive studies have been made to ascertain the water level history of this lake-bed area. Within the survey lines is an unsurveyed area which probably exceeds 200,000 acres, as to much of which there are claims by those who have cut hay and grazed stock upon the land, in addition to riparian claimants. This area within the lines has been examined in the land office for all possible correspondence and commitments and title examination has been begun in Harney County. The State engineer of Oregon has before him the settlement of numerous and conflicting claims to the waters of the Donner and Blitzen Rivers, which are based upon claims of prior appropriation. Water is necessary to this refuge, and this office prepared and presented evidence on this question with the assistance of the United States attorney, at Portland, Oreg., who has charge of the matter. The rights of the State of Oregon within this area are the subject of a suit to quiet title in the Supreme Court of Oregon. Extensive studies have been undertaken and material progress made in preparation for the hearings which will be held before a special master.

BEAR RIVER MIGRATORY BIRD REFUGE EXCHANGE ACT

(45 Stat. 1186)

Consideration has been given to the legal problems involved in land exchanges, in connection with the boundaries of the Bear River Migratory Bird Refuge. In three cases, the lands under considera-

tion involved about 20,600 acres. The status of these lands, as disclosed by the records of the General Land Office, has been ascertained. In two cases the exchange has been approved by the Department of the Interior and, in the third, further investigation of the history of the land with respect to the water levels of Great Salt Lake was found necessary, and progress has been made in this phase of the matter.

NATIONAL ARBORETUM

(44 Stat. 1422)

Five petitions for use in the condemnation of approximately 90 acres of land in the District of Columbia were prepared and submitted to the Attorney General. These cases were tried and jury awards made therein. In addition, advice was given to officials bearing on the problems connected with arboretum acquisitions.

MOUNT VERNON MEMORIAL HIGHWAY

(45 Stat. 721)

The Government has acquired by purchase and donation for the purposes of the Mount Vernon Memorial Highway 17 tracts of land, comprising approximately 458 acres, located in the city of Alexandria and in Arlington and Fairfax Counties, Va. Condemnation suits were instituted to accomplish 4 other acquisitions under this law. Of the 12 suits pending at the close of the last fiscal year, 2 were amicably settled before trial. In 8 cases the proceedings were in the nature of friendly suits, condemnation being sought because of defects in title or because the whereabouts of parties in interest were unknown. Two of the last mentioned cases were tried before the commissioners and awards were made, but the awards have not yet been considered and passed on by the court. There are still 14 condemnation cases pending final determination.

Examination of titles to four miscellaneous tracts of land were made as a preliminary to their acquisition by the United States.

Considerable time and attention were devoted to the completion of transfers of property for the purposes of the Memorial Highway, involving the negotiations of contracts with the owners, the preparation of deeds and other instruments of conveyances, and transacting other business arising out of the conduct of this work.

PACKERS AND STOCKYARDS ACT, 1921

(42 Stat. 159)

During the year 49 notices of inquiry were prepared as the basis of hearings under the act. Attorneys of this office appeared as counsel and officiated as examiner in a number of hearings held during the year involving the reasonableness of the rates and charges for stockyard services, and of rates charged by commission merchants, as well as in hearings based upon complaints of unfair and deceptive practices on the part of the operators on the yards or upon allegations of insolvency. The records of these hearings were carefully reviewed and digests made thereof by this office, in cooperation with the Packers and Stockyards Administration of the Bureau of Animal

Industry, and oral argument was made in some of the cases before the Secretary. Many legal problems bearing on the enforcement of this act were given consideration and opinions thereon were furnished to the administrative officials interested in their solution.

COURT CASES OF INTEREST

United States v. Donahue Bros. (Inc.). This case arose in the United States District Court for Nebraska, Omaha division, upon an action instituted by the Government to recover civil penalties on account of the alleged violation of a cease and desist order issued by the Secretary of Agriculture against the defendant. The Secretary had found that the defendant had made such use and disposition of funds in its possession as to endanger the prompt account for and payment of proceeds to consignors of livestock. The defendant disobeyed this order and several times made withdrawals from its shippers' proceeds account and further disposed of funds so as to endanger prompt accounting to its customers. The order, in addition to referring to the act, mentioned the Secretary's regulation requiring the keeping of a shippers' proceeds account. The court held that the Secretary was without authority to make such a regulation and accordingly dismissed the case, apparently disregarding the charge and finding of the Secretary that what was done constituted an unfair practice in violation of the act. The statute does not provide any discipline for a violation of a regulation. An appeal to the circuit court of appeals has been recommended by this department.

On April 27, 1931, the case of the Union Stockyards of Omaha, plaintiff, *v. T. G. Inghram*, defendant, was heard by the United States District Court for Nebraska. This was an action by the stockyards for the collection of charges regularly assessed against Inghram. A jury trial was waived by the parties. The court found that, before this action was instituted, Inghram had filed a complaint with the Secretary of Agriculture alleging that the tariff under which the charges sued for were assessed was unreasonable and discriminatory and praying for an order requiring the plaintiff to cease and desist from making the charges; that the Secretary of Agriculture on or about August 30, 1927, entered an order denying the relief and dismissing the proceeding; that the defendant thereupon filed an application for rehearing of the matter, which was denied; that the issues raised by the defendant in his answer in the court action were the same as were presented to the Secretary of Agriculture; that the court is without jurisdiction to review the same; and that the matters presented by the answer filed in the court do not constitute a defense to the action. The court thereupon held that the defendant was indebted to the plaintiff in the sum of \$334.66, with interest at 7 per cent per annum from June 30, 1930, with costs.

UNITED STATES GRAIN FUTURES ACT

(42 Stat., 998)

The hearing in the case against the three members of the Chicago Board of Trade mentioned in the last annual report was completed during the year but has not been disposed of.

Advice and assistance were given to administrative officers on questions arising in the administration of the act.

CASE OF INTEREST

The United States Circuit Court of Appeals, in *Lyons Milling Co. v. Goffe and Carkenar*, 46 Fed. (2d) 241, held that the Missouri statute relating to grain futures has no application to purchases or sales of grain for future delivery on a board of trade designated as a contract market in accordance with grain futures act. The court took judicial notice of the designation of the Kansas City Board of Trade as a contract market under the act, making it unnecessary to submit proof of the designation.

UNITED STATES WAREHOUSE ACT

(39 Stat. 486)

By an act of Congress approved March 2, 1931 (46 Stat. 1463), 10 of the 33 sections of the warehouse act were materially modified. This amendment necessitated changes in the several sets of regulations for the conduct of warehouses for various products stored under the act, all of which were reviewed by this office as to their legal sufficiency. It also gave rise to questions which were submitted to this office for legal advice concerning the scope of the amended act with reference to State laws. Other questions arising in the administration of the act, as to the rights and liabilities of warehousemen and their depositors, were also the basis of requests for legal advice.

CASES OF INTEREST

In a criminal proceeding in the United States District Court at Cincinnati, Fred W. Scholl and Elmer Voss, president and secretary-treasurer, respectively, of the Scholl elevator, the defendants, pleaded guilty to a violation of the act and each was fined \$100. The violation of the act consisted in unlawfully removing, from the company's licensed warehouse, 53,400 bushels of corn for which receipts has been issued by the company. These receipts had been deposited with a Cincinnati bank as security for a loan of \$41,000. It appears that these officials believing that corn prices would drop had sold corn short and when the market advanced they removed the corn from the warehouse in an effort to cover their margin and discounted the drafts of the purchasers. Discovery of the shortage in corn in the warehouse was made when the company went into the hands of a receiver.

PRODUCE AGENCY ACT

(44 Stat. 1355)

During the year 56 cases were referred to this office by the Bureau of Agricultural Economics. Of these, 27 were referred to the Department of Justice for prosecution. Of the others, some were returned to the bureau for further evidence or to be dropped and some are being held pending a conference with the Department of Justice for the consideration of what evidence is required to establish that the violation of the act is committed "knowingly and with intent to defraud."

Convictions were obtained in 15 cases.

CASES OF INTEREST

In *United States v. Rehwald*, 44 Fed. (2d) 663, the United States District Court for Southern California held that the words "account for" include payment or, in other words, that failure to remit proceeds of a sale constitutes a violation of the act. The decision will aid materially in the enforcement of the act and is of considerable interest because it was contended by some that the statute does not cover failure to remit. A brief on the question was prepared by this office for use in the prosecution.

In the case of *A. S. B. James*, of Richmond, Va., the defendant was convicted by a jury on October 14, 1930. The court fined him \$250 and imposed a jail sentence which was suspended until November 4 to allow the defendant an opportunity to remit a balance of \$425 to the shipper. The violation in this case was also a failure to make payments.

In three cases against *Louis Segari* and *Joseph O. Segari* for failure to remit the proceeds to the shippers and for false representations as to the amount received, the defendant, *Joseph O. Segari*, on February 20, 1931, appeared before the United States District Court for the Eastern District of Louisiana and entered pleas of guilty. In each case he was sentenced to four months in the House of Detention at New Orleans. The cases were nolle prossed as to *Louis Segari*.

UNITED STATES GRAIN STANDARDS ACT

(39 Stat. 478)

Public hearings for the purpose of discussing with the trade proposed amendments to the regulations issued under this act were attended by representatives of this office. The testimony and other evidence taken at hearings upon violations of the act and the proposed findings of fact for publication as authorized by the act were reviewed as to their legal sufficiency. Cases involving disciplinary action against licensed inspectors were also reviewed.

UNITED STATES COTTON FUTURES ACT

(39 Stat. 483)

No legal matters of special interest arose in connection with the administration of this act during the year. Consideration was given to the legal sufficiency of several amendments to the regulations and advice was given the administrative officers on various questions which arose in the administration of the act.

FEDERAL WATER POWER ACT

(41 Stat. 1063)

Opinions were rendered to the Forest Service on questions involving the interpretation and application of the Federal water power act in the administration of the national forests.

UNITED STATES COTTON STANDARDS ACT

(42 Stat. 1517)

Several amendments to the regulations issued under this act were considered as to their legal sufficiency, and advice and assistance were given to administrative officers on questions arising in the administration of the act.

STANDARD CONTAINER ACTS OF 1916 AND 1928

(39 Stat. 625; 45 Stat. 685)

Advice was given to administrative officers on questions arising in the administration and enforcement of these statutes.

CASES OF INTEREST

In *United States v. Certain Straight Side Baskets in the United States District Court for Colorado*, the court on October 13, 1930, entered a decree directing the destruction by the United States of 777 dozen straight-side baskets for fruits and vegetables manufactured by the Colorado Basket Co. of Grand Junction, Colo. These baskets had been seized pursuant to a libel for confiscation because they did not comply with the requirements of this act.

In *United States v. L. G. Tolles in the United States District Court for Connecticut*, the defendant was charged with offering for sale on September 13 and 15, 1930, a number of 14-quart baskets filled with apples. A plea of guilty was entered by the defendant February 25, 1931. Later he was permitted by the court to withdraw his plea of guilty and enter a plea of *nolo contendere*. The defendant was then fined \$5, without costs, on the first count and \$100, without costs, on the second count. The latter fine was remitted and the defendant placed on probation for two months in charge of his counsel.

In *United States v. Hall Packing Co. in the United States District Court for Southern California*, the defendants were charged with violating the standard container act of 1916, in that they shipped a large quantity of grapes in containers not conforming to the specifications of that act. These containers were what are known as "till baskets" of a capacity of $1\frac{1}{3}$ quarts. The standard basket named in section 2 of the act for small fruits, berries, and vegetables must be of the capacity of 1 quart or multiples thereof, unless of smaller sizes, for which the pint and the one-half pint are made standard. The defendants filed a demurrer contending that section 2 of the act is not applicable to the shipment of grapes because section 1 fixes standards for Climax basket for grapes. The Government contended that section 1 deals with standards for Climax baskets while section 2 deals with other types of containers and that if containers other than Climax baskets are used for grapes they must conform to the specifications of section 2. The court took the view that grapes are not subject to section 2 because they are named in section 1 and that the act does not forbid the use of containers other than Climax

baskets for the packing of grapes. In support of its position the court referred to publications of the department in which grapes were not classed as small fruits.

In *United States v. Pacific Fruit Exchange* in the United States District Court for the Northern District of California, the violation charged was the use of the same type and age of basket as in the Hall case for the shipment of plums. The defendant in that case also filed a demurrer practically the same as in the Hall packing case. The court sustained this demurrer without rendering an opinion.

In a case against William E. Asplin, doing business as Wm. E. Asplin Co., which was prosecuted in the United States District Court at Cleveland, Ohio, for a violation of the standard container act of 1928 the defendant was fined \$10 and costs and compelled to destroy 20 dozen 2-quart diamond-weave splint baskets for fruits and vegetables, which were illegal under the 1928 act.

In a case against Rocky River Basket Co. in the same court, a fine of \$10 was imposed and destruction was ordered of 70 dozen 2-quart splint diamond-weave overhandle baskets for fruits and vegetables which were illegal under the 1928 act.

CAPPER-VOLSTEAD ACT

(42 Stat. 388)

An opinion was given to the Bureau of Agricultural Economics that the administration of this act was not affected by the Executive Order of October 1, 1929, transferring from the bureau to the farm board the Division of Cooperative Marketing. The reasons assigned were that this act involves regulatory features and charges the Secretary of Agriculture with certain duties and vests him with certain powers which are not within the scope of the work of the board which is confined to the rendering of services, and that there is nothing in the order indicating any intention to transfer these duties and powers to the board.

A brief for the Attorney General was prepared on the question whether a cooperative association of agricultural producers, some of whose members or stockholders are corporations engaged in the production of agricultural products, is entitled to the benefits of the act, assuming that the association otherwise meets the requirements of the act.

FARM PRODUCTS INSPECTION LAW

Advice on questions incident to the service established under this law was given the administrative officers. Regulations applicable to additional commodities to which the service has been extended were reviewed for legal accuracy and sufficiency.

CASE OF INTEREST

A case of considerable interest under this law is that of the *United States v. Lou Mickel*, which was prosecuted in the United States District Court for the Eastern District of Washington. It involved the alteration of an inspection certificate. The certificate was issued at Wenatchee, Wash., in March, 1929, on a shipment of apples showing 4 per cent blue-mold decay. It was altered by Mickel to show

only 2 per cent blue-mold decay. An indictment charged him with violating section 72, title 18, of the United States Code, which among other things makes unlawful the alteration of public documents, including any "public record * * * or other writing for the purpose of defrauding the United States." A legal opinion by this office was given to the administrative officers that an inspection certificate is within the language of the law and that the alteration of the certificate interfered with the proper conduct of the inspection service and therefore was a fraud upon the United States. Prosecution was instituted on that basis and the defendant demurred to the indictment. In arguing the case to the court, his attorney did not question whether the inspection certificate was a public record or other writing or whether its alteration constituted a fraud on the United States. He contended that the inspection law was limited to interstate shipments and did not apply to the particular shipment involved, because it was intended for export and that, therefore, the issuance of the certificate was not authorized by law. At the request of the United States attorney a brief in response to this argument was prepared in this office showing that the application of the inspection law was not limited to interstate shipments as contended by the defendant. The United States attorney filed a new indictment, and on January 12, 1931, the defendant entered a plea of guilty and was fined \$100.

PERISHABLE AGRICULTURAL COMMODITIES ACT

(46 Stat. 531)

This being a new statute, considerable time was devoted to the consideration and preparation of regulations for its enforcement. Many requests for legal advice were submitted by the Bureau of Agricultural Economics and by persons affected by the act. There were received 102 cases from the bureau during the year. Some of these have been returned for various reasons. Others are in the course of preparation for hearings. In 13 cases hearings have been heard, but no decisions have yet been rendered in any of them.

COLLECTION AND DISTRIBUTION OF EXCESS PROFITS ON WOOL CLIP OF 1918

There was little activity during the fiscal year 1931 in respect to the collection and distribution of excess profits made by dealers in handling wools of the domestic clip of 1918. The reasons for this are that the work has dwindled to a point where only a relatively few cases are pending; practically all work preliminary to actual trial has been completed; and difficulty has been encountered in obtaining trials in these cases. The efforts of the year have been directed principally toward obtaining an authoritative decision upon the basic legal questions involved in three cases; one pending in the southern district of New York, one in the southern district of Indiana, and the other in the northern district of Illinois. One of these cases, namely, that against John E. McMurtry & Co., was tried in the district court in April, 1926, and decision reserved. It was reargued on July 31, 1930, and decided adversely to the Government.

Request was made of the Attorney General that an appeal be taken to the Circuit Court of Appeals for the Second Circuit, provided he was of opinion that the record was sufficient to present to the court the questions of substantive law involved. In this connection, an attorney of this office visited New York City and made a rather exhaustive study of the record. He also assisted the Solicitor General in a study of the matter. The conclusion was reached by the Department of Justice that the record was not the best that could be made for the purpose of presenting to the appellate courts the substantive legal questions on which an authoritative decision was desired. Accordingly, it was decided to prepare another case for the purpose.

The case selected was the one pending in the southern district of Indiana and the setting of it for trial on February 17, 1931, was procured. There was a continuance to March 23, 1931, at which time counsel for the defendants sought a further continuance. This was agreed to on condition that the defendants permit a reaudit of their books and records, which this department had been seeking for some years without success. As a result the reaudit was made and previous omissions supplied, rendering the Government's case reasonably secure on the facts and leaving practically only the question of law in doubt. It is now promised that this case will be set for trial at the fall term 1931 of the United States District Court for the southern district of Indiana.

At the close of the preceding fiscal year, the case referred to as pending in the northern district of Illinois, namely, that against S. Silverman & Sons, was pending on demurrer to the amended declaration. A brief prepared in this office had been filed. On December 2, 1930, the court overruled the demurrer, thereby sustaining the Government's position with respect to the law. Thereafter, the defendant pleaded, and for some months the case has been ready for trial. Repeated efforts have been made to have this case set for trial but without success thus far. These have consisted both of correspondence and personal interviews made by an attorney of this office. This case presents some questions dissimilar from those raised in the case pending in the southern district of Indiana.

SEED AND AGRICULTURAL CREDIT LOANS

Considerable aid was given the administrative officials of the department in connection with the making of loans to farmers in the drought-stricken areas of the United States pursuant to the provisions, terms, and conditions contained in joint resolution of December 20, 1930 (46 Stat. 1032), carrying an appropriation of \$45,000,000; the amendment thereto of February 14, 1931 (46 Stat. 1160), making an additional appropriation of \$20,000,000, for the purpose of forming agricultural credit corporations and like organizations, and assisting those already in existence; and the act of February 23, 1931 (46 Stat. 1276), appropriating \$2,000,000 to enable the Secretary of Agriculture to make loans to farmers in the States of Alabama, North Carolina, South Carolina, Georgia, and Florida, who suffered storm or drought losses to crops in 1929 and 1930. Opinions were rendered on many questions arising in the several States in connection with the disbursements of these appropriations; in several cases,

proofs of claim were prepared and filed in bankruptcy proceedings where seed loans were involved; numerous conferences were held by attorneys of this office with administrative officials in connection with the preparation of regulations, forms of application, mortgages, liens, and the like, devised for use in the several States; advice was furnished to administrative officials, both orally and in writing, as to procedure to be followed in different jurisdictions in order to secure and obtain payments of loans made; complete information and evidence were compiled and forwarded to the Attorney General for action in 21 cases requiring civil or criminal proceedings against borrowers and others; and much data and miscellaneous legal information in connection with seed loans were furnished to interested farmers and other persons throughout the country.

In connection with loans made under the provisions of the act of February 14, 1931, to 530 stockholders of 34 agricultural credit corporations and like organizations, located in 17 different States, to whom \$743,404.57 has been advanced by the Secretary of Agriculture during the fiscal year, in order to assist in their organization and to increase the corporation stock of those already in existence, much work of a legal nature was performed. Prior to the appointment of the National Advisory Loan Committee and the perfection of the present method of procedure, this office devised and improvised the necessary regulations and forms for use in the administration of this particular phase of the act. After the committee had begun to function and loans were actually being made, it then became necessary for the office to furnish advice and assistance to members of the committee and other administrative officials with respect to the validity of the securities offered to the Government as collateral for loans as well as to pass upon the legal status of the credit corporations in question, under the laws of the States where they had obtained charters. In this connection, a number of opinions were rendered upon technical corporation questions and legal advice was frequently furnished, both orally and in writing, to the committee upon less important phases of the work.

MISCELLANEOUS TITLE EXAMINATIONS

During the year examination of titles to 54 tracts of land in Barton County, Kans., comprising approximately 20,000 acres, was completed. This land was acquired for use as a part of the Cheyenne Bottoms Migratory Bird Refuge. Also title investigation was completed as to 217.6 acres within the exterior limits of the Niobrara reservation in Cherry County, Nebr., and partially completed as to 175.28 additional acres, which acquisitions are intended for use of that reservation. In addition, examination of title to a tract of land, comprising 18.11 acres, adjacent to the National Bison Range in Lake County, Mont., was made and reports thereon submitted to the Attorney General for his consideration and approval.

PATENTS

During the year 124 applications for letters patent on inventions of employees of the department were pending in the United States Patent Office (as shown in Table 11. below), of which 23 were filed

during the past fiscal year. Of these applications, 24 were passed to patent. There are pending before the Patent Office 84 applications. The office has taken part in 11 interference proceedings declared by the Patent Office between applications for letters patent of employees of this department and applications filed by outside parties. Two of the interference proceedings were concluded favorably to and one against the Government. In one instance, it was considered inadvisable to prosecute. Seven such proceedings remain in litigation. Briefs were prepared and filed and oral arguments made before examiners and boards of the Patent Office. Numerous responses to actions by the Patent Office were also prepared and filed.

Many questions were considered bearing on various phases of patent law.

TABLE 11.—*Status of applications for patents by members of the Department of Agriculture on June 30, 1931*

Applicant	Bureau or office	Invention	Disposition of application
Baker, G. L.	Experiment Stations	Pectin	Pending.
Myers, P. B.			
Barger, W. R.	Plant Industry	Preservation of fruit	Rejected.
Do	do	do	Do.
Do	do	do	Pending.
Barghausen, John F.	Agricultural Economics	Apparatus for branding cheese	Do.
Do	do	Marking machine	In interference.
Beare, W. L.	Public Roads	Resilient connections	Pending.
Bell, Raymond W.	Dairy Industry	Manufacture of milk sugar	Do.
Bennett, C. A.	Public Roads	Seed cotton dryer	Do.
Do	do	Process and method for ginning cotton.	Do.
Bonney, Victor B.	Food and Drugs	Apparatus for testing fruits and vegetables.	Do.
Clifford, Paul A.			
Breakey, J. F.	Plant Industry	Portable spray	Do.
Brook, Charles	do	Refrigeration	Patented.
Carter, Roscoe H.	Chemistry and Soils	Insecticide	Pending.
Do	do	do	Do.
Do	do	do	Do.
Do	do	do	Do.
Do	do	do	Rejected.
Do	do	do	Pending.
Cheatham, Robert J.	Agricultural Economics	Fabric bag	Do.
Coe, Mayne R.	Chemistry and Soils	Preservation oil-bearing commodities.	Do.
Conover, Courtney	do	Dye	In interference.
Gibbs, H. B.			
Cooley, J. S.	Plant Industry	Tree dressing	Pending.
Do	do	do	Do.
Do	do	Preventing fruit decay	Do.
Cotton, Richard T.	Entomology	Carbon dioxide fumigant	Do.
Young, Harry D.	Chemistry and Soils	do	Do.
Cottrell, Frederick G.	do	Ions	Do.
Cruess, William V.	do	Fruit confections	Do.
Do	do		
Mrak, E.	do	Prune pulp	Do.
Dana, B. F.	do		
Musgrove, C. F.		Fungicide	Do.
Dantzig, T. B.	Home Economics		
Peterson, E.		Measuring device	Do.
Dieffenbach, Emory M.	Plant Quarantine	Destruction of insect larvae	Patented.
Dorset, M.	Animal Industry	Vaccine	Do.
Fulton, Harry R.	Plant Industry	Sodium peroxide	Rejected.
Bowman, John J.	do		
Fulton, Harry R.		Sodium aluminate	Patented.
Bowman, John J.	do	Sodium sulphate	Rejected.
Fulton, Harry R.	do	Manganese salts	Patented.
Bowman, John J.	do	Cerium chloride	Rejected.
Fulton, Harry R.	do	Nickel salts	In interference.
Bowman, John J.	do		
Fulton, Harry R.	do	Decay in fruits	In interference, rejected.
Bowman, John J.	do		

TABLE 11.—*Status of applications for patents by members of the Department of Agriculture on June 30, 1931—Continued*

Applicant	Bureau or office	Invention	Disposition of application
Funke, Fred W.	Forest Service	Fire-fighting tool	Pending.
Gardiner, R. F.	Chemistry and Soils	Fertilizer	Do.
Walton, G. P.		Para-phenyl	Allowed.
Groggins, P. H.	do	do	Patented.
Do.	do	do	Do.
Do.	do	do	Pending.
Do.	do	do	Do.
Do.	do	do	Patented.
Do.	do	do	Do.
Do.	do	do	Rejected.
Do.	do	do	Allowed.
Do.	do	do	Do.
Do.	do	do	Do.
Do.	do	do	Patented.
Do.	do	do	Allowed.
Do.	do	do	Patented.
Do.	do	Acid	Do.
Do.	do	Resinous compound	Pending.
Haig, I. T.	Forest Service	Calculating device	Rejected.
Kempff, J.			
Hansen, K. B.	Biological Survey	Mouth speculum	Pending.
Mehalik, J. S.			
Harper, V. L.	Forest Service	Cutting tool	Do.
Henry, A. M.	Food and Drugs	Removal of spray from fruits	In interference.
Do.	do	do	Do.
Heritage, C. C.	Forest Service (Madison, Wis.)	Semisulfate pulp	Pending.
Howard, Burton J.	Food and Drugs	Ruling apparatus	Do.
Irish, J. H.	University of California	{ Process for preparing powdered or dried fruit juices.	{ Do.
Cruss, W. V.			
Richert, P. H.	Plant Industry	{ Vaporizing and diluting sulphur dioxide.	{ Rejected.
Jacob, H.			
Winkler, E.	Oregon State Agricultural College	Fowlpox	Pending.
Johnson, Walter T.	Chemistry and Soils	Rotenone	Do.
Jones, H. A.	do	Tannic acid in acetone	Do.
Kadel, B. C.	Weather Bureau	Wind vane	Do.
Krase, H. J.	Chemistry and Soils	Urea	Do.
Hetherington, H. C.		Process for prevention of fungus attack on lumber.	Do.
Lingren, Ralph M.	Plant Industry	do	Do.
Do.	do	do	Do.
Do.	do	do	Do.
Loughborough, W. K.	Forest Service	Hydrosopic moisture instrument.	Rejected.
McBirney, S. W.	Public Roads	Stalk cutter	Pending.
McDonald, E. W.	Plant Quarantine and Control Administration	{ Machine for detecting bollworm in gin trash.	{ Do.
Pinck, G. J.			
Nickerson, Dorothy	Agricultural Economics	Measuring color	Do.
Offord, Harold R.	Plant Industry	Waterproofing material	Do.
Van Atta, George R.			
Offord, Harold R.	do	Destruction of weeds	Do.
Van Atta, George R.	Food and Drugs	Ether	Do.
Palkin, S.		do	Do.
Watkins, Howard R.	do	do	Do.
Palkin, S.	Public Roads	Intergrating meter	Do.
Watkins, Howard R.	do	Recording apparatus	Do.
Parshall, Ralph L.	do	Varnish	Do.
Phillips, Max	Chemistry and Soils	Method of nitrating cellulose	Patented.
Pinck, L. A.	do	Cedar chest	Pending.
Rabak, Frank	Plant Industry	Insecticide	Patented.
Roark, R. C.	Chemistry and Soils	do	Pending.
Do.	do	Control of plant and animal organisms.	Rejected.
Roark, R. C.	Chemistry and Soils and Entomology	Ethylene oxide	{ In interference, patented.
Cotton, R. T.			
Roark, R. C.	Chemistry and Soils	{ Ethylene dechloride	{ Rejected.
Cotton, R. T.			
Roark, R. C.	Entomology		
Cotton, R. T.	Chemistry and Soils	Moth-proofing composition	Pending.
Back, E. A.	Entomology		
Cotton, R. T.	Chemistry and Soils	Moth-proof articles	Rejected.
Roark, R. C.	Entomology		
Back, E. A.	Chemistry and Soils	Fungicide	In interference, patented.
Cotton, R. T.	Plant Industry		
Roberts, John W.			

TABLE 11.—*Status of applications for patents by members of the Department of Agriculture on June 30, 1931—Continued*

Applicant	Bureau or office	Invention	Disposition of application
Robinson, Reginald H.	Oregon State Agricultural College.	Spray residues.	Pending.
Do.	do.	Natural oil.	Do.
Rogers, L. A.	Dairy Industry.	Process and apparatus for preserving cheese.	Do.
Do.	do.	do.	In interference.
Do.	do.	do.	Pending.
Do.	do.	do.	Do.
Rue, J. D.	Forest Service.	Pulp.	In interference.
Wells, S. D.			
Rawling, F. G.	Animal Industry.	Parasiticides.	Pending.
Schaffer, J. M.			
Tilley, F. W.	do.	Germicide.	In interference, rejected.
Schaffer, J. M.			
Do.	do.	Antigens.	Patented.
Schuster, C. E.	Oregon State Agricultural College.	Strawberry.	Pending.
Siegler, E. H.	Entomology.	Tree bands.	Allowed.
Do.	do.	do.	Pending.
Snapp, O. I.	do.	Insecticide.	Do.
Stamm, O. J.	Forest Service.	Electrical contact.	Do.
Suits, T. J.	do.	Moisture-indicating instrument.	Do.
Dunlap, M. E.	Chemistry and Soils.	Method of obtaining oil from peel of citrus fruit.	Do.
Sutton, W. E.			
Swenson, T. L.	do.	Preserving eggs.	Rejected.
Do.	do.	do.	Pending.
Thelen, R.	Forest Service.	Process for fuming wood.	Do.
Tilden, H. G.	Entomology and Plant Quarantine and Control Administration.	Process for treatment of fruit.	Do.
Yothers, W. W.			
Turrentine, John W.	Chemistry and Soils.	Decolorizing, purifying, and absorbing agents.	In interference.
Weyman, L.	Forest Service.	Cutting tool.	Pending.
Winston, John R.	Plant Industry.	Coloring fruits and vegetables.	Do.
Wright, Robert Claude.			
Wooten, John F.	Chemistry and Soils.	Process for oxidizing ammonia.	Rejected.
Yee, J. Y.			
Do.	do.	Apparatus for oxidizing ammonia.	Pending.
Zern, L.	Dairy Industry.	Chocolate milk.	Do.
Munkwitz, R. C.			

CASES OF INTEREST

In the case of *U. S. v. Dubilier Condensor Corporation*, the Government sought to obtain a decree in the United States District Court for the District of Delaware, compelling the defendant to convey to the United States all defendant's right, title, and interest in certain letters patent issued to Francis W. Dunmore and Percival D. Lowell. The asserted title of the Government was based on the claim that the inventions involved belonged to the United States, by virtue of the conditions or terms of employment of the inventors in the United States Bureau of Standards. The patents under consideration involved the use of ordinary house-lighting alternating current in the operation of radio apparatus and of means for eliminating hum, caused by the alternations of such current. It was disclosed that the Bureau of Standards was divided into divisions, one of which was the Electrical Division. These divisions in the bureau in turn were divided into sections, one of which, in the Electrical Division, was the radio section in which Dunmore and Lowell, the inventors involved, were employed. The technical employees in the radio section were divided into 10 groups. Dunmore and Lowell were assigned to the airplane radio group and were not members of the

group to which was assigned radio receiving sets. The patents involved in the suit covered "improvements in radio receiving apparatus," a "power amplifier," and a "single-receiving system." Under these circumstances, the court, while not seriously questioning the principle that, when an employee merely does what he is hired to do, his successes, as well as his failures, belong to his employer, held that the specific problem or problems solved by the inventions involved were not assigned to Dunmore and Lowell. The bills of complaint were dismissed. It is understood, however, that an appeal in the case will be taken by the Government.

In an opinion handed down on March 2, 1931, the Supreme Court of the United States, in *America Fruit Crowers (Inc.) v. Brogdex Co.* on certiorari, reversed the lower courts and held Patent 1529461, involving the use of borax in the preparation of fresh fruits for market, issued to Brogden & Trowbridge, invalid. The court unanimously took the position that the product claims of the patent in suit were improper and that the process claims were invalid because anticipated by a prior patent to Simeon Bishop involving the use of boracic acid in the preservation of foods. As to the product claims, it was necessary to determine, for example, whether an orange, the rind of which had become impregnated with borax through immersion in a solution and thereby rendered resistant to blue-mold decay, was a "manufacture" or a manufactured article within the meaning of the patent laws. In answering this question, the court said, in effect, that the addition of borax to the rind of natural fruit does not produce an article having a new or distinctive form or property, that there is no change in the name, appearance, or general character of the fruit, but that it still remains a fresh orange.

Unusual interest was shown in the consideration of the last-mentioned case because of the alleged embarrassment of the fruit trade in the orderly and lawful pursuit of its business. This interest was manifest by the filing of briefs as *amici curiae* by the United States and several of the States. The interest of the United States Department of Agriculture in the controversy was due to the fact that it had conducted investigations involving the treatment of fruits and vegetables with boracic acid in the early part of 1900, although publications on the subject were not issued until a number of years later and after additional studies had been undertaken. It was urged by the Government that the patent in issue, if valid, imposed upon dealers in, and consumers of, a food product of general consumption throughout the nation the duty of inquiring whether the product had been dipped in a solution of borax, the effect of which is perceptible only by chemical analysis or microscopic examination, and further that the invention involved was not new and original. Because of the possible effect of the decisions of the lower courts on the research work of the department, a final determination of the question presented was important.

The work of the office, considering its nature, was current at the end of the year.

UNITED STATES DEPARTMENT OF AGRICULTURE
WEATHER BUREAU
WASHINGTON, D. C.

August 29, 1931.

SIR: I submit herewith a report of the work of the Weather Bureau during the fiscal year ended June 30, 1931.

Respectfully,

C. H. Marvin.

Chief.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

LEGAL FUNCTIONS OF BUREAU

In order that readers interested in the study of these periodical reports of the activities and service of the Weather Bureau may be informed regarding the duties of this bureau, it seems appropriate to cite briefly the specific acts of Congress which outline and define the functions of this Federal organization.

In the act of Congress transferring the meteorological work of the Signal Office to the Weather Bureau of the Department of Agriculture, approved October 1, 1890, the duties of the service are thus summarized:

The Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, shall have charge of forecasting the weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gaging and reporting of rivers; the maintenance and operation of seacoast telegraph lines and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature and rainfall conditions for the cotton interests; the display of frost, cold-wave, and other signals; the distribution of meteorological information in the interest of agriculture and commerce; and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, as are essential for the proper execution of the foregoing duties.

All the meteorological work of the Government developed under these and older equivalent laws applicable while the Weather Bureau was a part of the Signal Corps of the War Department, up to the advent of civil aviation.

With the passage of the air commerce act, approved May 20, 1926, it was considered expedient to legally define the duties and responsibilities of the Weather Bureau relative to air navigation, by the following new legislation:

Section 3 of the Act entitled "An Act to increase the efficiency and reduce the expense of the Signal Corps of the Army, and to transfer the Weather Service to the Department of Agriculture," approved October 1, 1890, is amended by adding at the end thereof a new paragraph to read as follows:

Within the limits of the appropriations which may be made for such purpose, it shall be the duty of the Chief of the Weather Bureau, under the direction of the Secretary of Agriculture, (a) to furnish such weather reports, forecasts, warnings, and advices as may be required to promote the safety and efficiency of air navigation in the United States and above the high seas, particularly upon civil airways designated by the Secretary of Commerce under authority of law as routes suitable for air commerce, and (b) for such purposes to observe, measure, and investigate atmospheric phenomena, and establish meteorological offices and stations.

It seems proper to make the general statement that under these specific laws, as supported by the current annual appropriations, the activities of the bureau in all its varied lines are in a state of wholesome growth, development, and efficiency. From its very nature our work is intimately identified with reporting the constantly changing picture of the passing weather. As such we must, and we believe we may justly claim to be, figuratively "up to the minute" in our knowledge of atmospheric conditions, not only over the continental United States and its possessions, but through international cooperation and exchanges, over the greater part of the Northern Hemisphere. This alertness to existing conditions by means of extended systems of frequent observations and reports engenders habits of promptness and efficiency that are reflected in all the work of the bureau.

It is this same widespread system of frequent simultaneous observations and reports that forms the basis for the daily forecasts, warnings, and advices as to near-future weather conditions.

Thus it is seen that the forecaster, from his position of up-to-the-minute knowledge of present weather all over the world, aspires to perform the duty imposed upon him by the laws cited above by telling the public just what he thinks the weather is going to be. Even though certain conjectural factors surround the effort, the bureau believes it is fully justified in claiming that its forecasts of storms, floods, cold waves, hurricanes, etc., constitute a very valuable public service.

EXTENDING THE PERIOD OF FORECASTS

Throughout its history, the bureau has made efforts to extend the period over which successful forecasts could be issued as far as practicable. With the advent of radio, giving us a more complete picture of world weather conditions, the bureau inaugurated some years ago its so-called weekly outlook, in which the forecast is made to cover approximately a week in advance. Furthermore, within its organization, studies have always been in progress to determine, if possible, methods by which forecasts for months, seasons, and even years in advance could be formulated, and such studies still constitute a part of the program of research within the bureau organization. It is believed that the views of the bureau are in accord with those of leading meteorologists throughout the world, that up to the present time no sufficiently conclusive scientific basis has been found on which to make successful forecasts of this character.

It may be mentioned again that there appear to be three methods of approach in this matter, namely, (1) the direct physical process of cause-and-effect relationship between known physical causes and attendant weather conditions; (2) the so-called periodicities or cyclical recurrences of weather phenomena, either in the sequence of conditions themselves or as correlated to some astronomical or other sequence of events; (3) the mathematical correlations between the present weather in one locality with either past weather in the same locality or the past weather in some other locality. It is only fair to say that the bureau has conducted very intensive investigations in one or the other of these possible lines of approach without as yet having found

a sufficiently sound basis yielding possibilities of successful forecasting. Furthermore, the bureau is abreast of the information in these fields to be found in the literature contributed by other students, in the United States and elsewhere.

OBSERVATIONS AND REPORTS

The need for more detailed information from the existing network of stations reporting to the Weather Bureau and a further enlargement of the field of observation has become urgent. Demands for specialized forecasts, clamors for extending the forecasts beyond the periods now covered, the increasing distances traveled by man in comparatively short time intervals, all combine to make it more essential than heretofore that weather information be collected speedily not only from the North American continent but from the adjacent oceans and considerable portions of other continents.

Progress toward these ends has been made in the past year. Plans were completed to secure by telegraph much-needed additional data from the existing stations of the Weather Bureau and of the Canadian Meteorological Service. Detailed information concerning barometric changes taking place during the three hours preceding the observation, reports of relative humidity, and data regarding time of occurrence and character of precipitation are the more important items provided for in the new scheme.

Furtherance of the international selected-ship program, described in previous reports, is yielding an increased number of ships' weather reports from the North Atlantic. Additional ships of United States registry were secured for making reports by radio to the Weather Bureau when in the Atlantic west of 35° W. and to European meteorological services when east of 35° W. In addition, a beginning was made in the selected-ship service for the southern Atlantic, Caribbean Sea, and Gulf of Mexico.

In accordance with the program of international cooperation, radio reports were received by the Weather Bureau in increasing numbers from ships of foreign registry when in the

western Atlantic. These are included in bulletins along with observations from our own reporting ships and broadcast for the benefit of marine and other interests.

Reports from United States and foreign selected ships in the eastern Atlantic, transmitted to European services, have been included in a bulletin transmitted to the Weather Bureau. During the past year a new arrangement was set up whereby ship reports from the eastern Atlantic and weather information from representative land stations in Europe and Asia are transmitted twice daily to the Weather Bureau from the British Meteorological Service through the powerful radio station at Rugby. These bulletins are being copied by the Navy radio station at Bar Harbor, Me., and forwarded to the Weather Bureau by land line. This service from Rugby corresponds to a similar bulletin containing reports from ships west of longitude 35° W. and land observations from stations in the United States, Canada, Alaska, Central America, the West Indies, etc., which is broadcast twice daily directly from the Weather Bureau in Washington through the Navy station at Arlington for the benefit of European meteorological services. Through these cooperations an excellent exchange of meteorological information between America and Europe is secured.

Preparation of general forecasts and warnings as well as specialized information was facilitated by the increased number of ship reports available from certain areas of the Atlantic and by the international exchanges.

FORECASTERS IN TRAINING

Increasing demands upon the Weather Bureau for special forecasts to serve aviation, forest protection, and numerous agricultural and other interests, have made it imperative that an ample corps of trained and experienced forecasters be available. To this end the bureau has established a class of forecasters in training, funds for the purpose having been first added to the appropriations for the fiscal year just ended.

Selections for the class were made from among the employees

of the bureau having the requisite educational qualifications and experience in the general work of the bureau. Training of this group began at the central office in Washington where intensive instruction was given in the preparation of weather maps and practical experience was gained in making daily forecasts of weather and temperature. A series of lectures on meteorology and the application of mathematics and physics to forecasting problems was an important part of the class work.

As this training progressed, the six members of the class showing the greatest aptitude for the work were chosen to continue, and the others were given appropriate field assignments.

At the termination of the detail in Washington, these six employees were assigned in pairs to three important field forecast centers, those in Chicago, Denver, and San Francisco. Instruction in meteorology and related phases of physics and mathematics is being continued by correspondence from the Central Office.

GENERAL WEATHER CONDITIONS OF THE YEAR

Perhaps never in the history of the country, certainly not in the history of the Weather Bureau, has there occurred such a long period of deficient precipitation over such a large section of the country, designated by the term "drought," as has prevailed for the past 12 to 15 months. This entailed such serious consequences to the agricultural and industrial conditions of the country as to deserve particular descriptive discussion.

As a result of the concentrated attention by the several experts of the bureau to statistics and reports of the drought conditions and diversities of views among them as to just how droughts should be defined and their characteristics classified, a small committee was formed to propose a specific definition. For this purpose the views of certain leading field officials were invited. It is believed appropriate to give here a brief outline of the work of this committee, whose full report will be otherwise published.

There was a complete unanimity of opinion among the field men on what seemed to them to be the insuperable difficulty of formulating a definition of drought that would apply to all cases that might arise. The committee, of course, could no more define drought in all of its phases than it could religion, for example.

From the beginning the committee recognized the futility of attempting to formulate a definition against which some objection would not lie, but it had hoped that out of the discussion a method of comparing previous droughts with those of the present and those which may come in the future would arise.

On the basis of the findings of the committee the bureau will hereafter compile the following-named major characteristics of droughts, whereupon it will be possible to present an accurate picture of the drought in its essential features:

Duration.

Deficit of rainfall with respect to the normal for the time and place.

Amount of past moisture, as indicated by the rainfall previous to the beginning of the drought, for example, within the previous month.

Area involved.

Statistics of areas involved in past droughts are not available, and it is doubtful whether it is now possible to compile them. The idea of making a rigid comparison of past with present or future droughts in respect of area involved is beset with difficulties, but statistics collected will be valuable hereafter.

In the last 30-odd years several voluntary attempts have been made to compile the rainfall statistics for previous droughts. The committee referred especially to the compilations made at New York City and Nashville, which were published in the Monthly Weather Review for November, 1914, and September, 1925, respectively.

The idea which the committee had in mind was not to set an

arbitrary figure which shall be considered as indicative of severe drought, but rather to have compiled for the stations east of the Rocky Mountains (roughly) statistics upon periods of deficient rainfall.

The specific definition to which these considerations led the committee is as follows:

Drought: A lack of rainfall so great and long continued as to affect injuriously the plant and animal kingdoms and to deplete water supplies both for domestic purposes and for the operation of power plants, especially in those regions where the rainfall is normally sufficient for such purposes.

In connection with these views of the experts on the question, the following more detailed account of weather conditions for this fiscal year is of interest.

In the report of the work of the Weather Bureau for the fiscal year ended June 30, 1930, details of the unprecedented drought of last summer were given up to and including August. The following is a brief summary of conditions for the subsequent months of 1930, for the year as a whole, and for 1931 through July.

After the disastrous summer drought, the fall months of 1930 brought substantial relief throughout the Southern States, and also rather generally in all sections from the Mississippi Valley westward to the Rocky Mountains, practically all parts of these areas having more than normal rainfall. Deficiencies continued, however, from the Ohio Valley northward and eastward, particularly in the middle-Atlantic area, where most places had only about half the normal, or even less, especially the Virginias, Maryland, and Pennsylvania. The fall rains in the winter-wheat belt were opportune, and very favorable in permitting the preparation of land and the seeding of grain, and in promoting good germination and early growth. They were also helpful for fall crops of all kinds in the Southern and South Central States.

Complete records for the 12 months of 1930 show that Oregon, Missouri, Tennessee, Kentucky, Indiana, Ohio, Michigan, West Virginia, Virginia, Maryland, Delaware, New Jersey, Pennsylvania, New York, and New England had the driest year on record. In Kentucky, West Virginia, and Virginia, the 1930 rainfall was 20 per cent, or more, below the previous low record, while in Maryland it was about 30 per cent below the lowest for any year since state-wide data have been maintained. Forty of the forty-eight States had below-normal rainfall. The final figures for the year as a whole conclusively show that the 1930 drought easily takes first place for severity in the climatological history of the United States.

Following the fall rains over wide areas, the winter (December-February) was remarkable for abnormal warmth and dryness over much the greater portion of the United States. The temperature averaged from 4 to 16 degrees above normal in central and northern areas of the country, and there was a marked absence of extremely cold weather, with subzero temperatures confined to the Northern States. Precipitation was generally scanty. It was the driest winter of record in Alabama, Indiana, Illinois, Michigan, Wisconsin, Iowa, Minnesota, North Dakota, Montana, Wyoming, and Oregon, and the driest since 1900-1 in New York, New Jersey, Pennsylvania, Maryland, West Virginia, Kentucky, and South Dakota, and, with one exception, the winter preceding, also in Virginia. Only five States had as much as normal rainfall.

The accumulation of snow in the western mountains which supplies water for irrigation purposes was also markedly deficient. In western Utah, Nevada, Arizona, and practically all portions of the Pacific Coast States, the winter ended with the smallest, or nearly the smallest, supply of stored snow in the mountains that has been known for 20 years. Also the shortages were marked in Montana, especially from the crest of the Continental Divide eastward. The least shortages were in the Rocky Mountain States from central Wyoming southward, where some drainage areas had about the normal amounts. New Mexico was the only Western State having as much as the normal winter snowfall.

The spring months (March-May) of 1931 had very favorable

rains, mostly above normal, throughout the Atlantic areas. In the central valley States, where drought was severe last year, the totals for the season were near normal, though all States between the Rocky and Appalachian Mountains had deficiencies, with the greatest shortages centering in the Northwest, principally in North Dakota and Montana. Except in the Northwest and in some more western districts, the spring season had sufficient moisture rather generally for crop needs. At the beginning of summer, the Atlantic area and the Ohio and middle-Mississippi Valleys were much better supplied with soil moisture than at that time last year, but the Northwest had considerably less than a year ago, and rain was badly needed over considerable areas.

June was very warm in the North, and extremely dry in much of the South, especially the Southeast, while the Northwestern States continued markedly deficient in moisture, particularly the eastern Great Basin, Idaho, Montana, and the Dakotas. The acute drought condition that developed in the Northwest was due to a combination of deficient precipitation in the present year, coupled with an accumulated shortage in recent past years. In Iowa and North Dakota this is the third year with deficient rainfall, and in Montana the fourth, while in Minnesota it has been deficient every year since 1919. In other sections there was sufficient rain to maintain crops in generally good condition, especially in much of the area that suffered most last year.

July was warm and dry in the central and northern sections of the country, especially in the western and northwestern Corn Belt, but in the South and East there was mostly abundant rain, and crops made unusually good progress. Small grains in the Northwest suffered severely from the heat and drought, while corn, potatoes, and other row crops deteriorated badly in many places from the western Lake region and upper Mississippi Valley westward. There was insufficient moisture for pastures and hay rather generally in the central valleys and the Northwest, and much feeding of stock was necessary in many central-northern localities, but in the East and South conditions, as a whole, were highly favorable.

Table 1 contains a summary of precipitation data for all

States, arranged geographically, since the beginning of the 1930 growing season, up to and including July, 1931, as follows: Spring, summer, and fall of 1930; winter of 1930-31, and for the months of March to July, 1931, separately. The contrast between this summer's rainfall and that of last year has been especially marked over a wide belt extending from the central-Mississippi valley eastward to the Atlantic ocean, where last year's shortages were the greatest. For example, the average July rainfall last year in Arkansas was only 20 per cent of normal, compared with 157 per cent this year; Tennessee, 54-110; Missouri, 24-81; Illinois, 30-88; Indiana 53-91; Kentucky, 30-93; West Virginia, 41-106; Virginia, 38-117; and Maryland 36-105.

(over)

Table 1. Percentage of normal precipitation by seasons, spring, 1930, to winter 1930-31, and for March,--July, 1931

	1930			Winter, 1930-31	1931				
	Spring,	Summer,	Fall,		March,	April	May	June	July
New England	95	89	79	71	116	89	127	164	114
New York	97	85	68	71	76	112	136	93	137
New Jersey	68	87	75	62	107	78	100	131	92
Pennsylvania	80	62	52	62	84	99	132	90	121
Md. & Delaware	64	48	41	61	117	92	125	92	105
Virginia	62	51	52	67	96	110	138	75	117
N. Carolina	67	59	94	70	85	116	120	52	102
S. Carolina	75	71	116	72	75	106	131	46	91
Georgia	95	75	151	68	62	84	99	41	83
Florida	155	93	113	110	171	167	85	32	82
Alabama	78	66	182	62	66	80	84	35	105
Mississippi	93	47	154	70	80	45	90	55	181
Louisiana	79	56	165	93	89	48	73	42	100
Texas	98	56	139	132	121	73	66	61	118
Oklahoma	93	67	98	118	136	84	62	50	113
Arkansas	93	36	131	74	89	54	69	65	157
Tennessee	86	50	97	66	71	81	67	43	110
Kentucky	50	43	61	56	78	112	63	66	93
West Virginia	64	53	44	67	89	117	130	73	106
Ohio	65	56	66	53	62	134	85	92	98
Indiana	54	61	80	42	79	90	74	94	91
Illinois	57	60	93	40	86	79	106	82	68
Michigan	82	62	69	54	92	60	103	111	60
Wisconsin	83	81	80	46	101	48	49	114	57
Minnesota	92	69	126	37	108	43	75	95	66
Iowa	78	83	85	39	95	78	65	83	71
Missouri	59	54	111	69	100	81	97	60	81
Kansas	96	84	149	60	168	93	76	54	70
Nebraska	130	89	138	53	158	56	63	64	57
South Dakota	87	74	124	37	114	36	63	69	52
North Dakota	83	67	115	40	113	31	55	67	116
Montana	85	68	120	38	92	48	43	52	116
Wyoming	87	143	103	41	105	73	84	67	98
Colorado	87	123	103	59	88	67	94	83	57
New Mexico	85	103	123	118	118	228	92	56	95
Arizona	160	123	110	120	20	166	83	179	103
Utah	91	151	121	35	58	75	67	41	79
Nevada	139	85	157	42	51	87	45	96	38
Idaho	110	93	94	51	154	66	41	46	45
Washington	90	56	71	79	177	95	52	222	24
Oregon	85	47	70	45	133	67	37	185	2
California	95	26	78	51	38	75	95	249	44

RIVER AND FLOOD CONDITIONS

There were no important floods in any part of the country in the year that ended on June 30, 1931. In fact, on account of the protracted period of dry weather many streams were unprecedentedly low. In the Mississippi system the lowest stages were above the confluence of the Ohio; over the Ohio basin there was enough rain to give stages below Cairo that were comparatively higher than those that prevailed in the upper valley. The St. Louis stages are fairly representative of the entire drainage of the upper Mississippi Basin, as the increment between the mouth of the Missouri and the mouth of the Ohio is small, and at St. Louis, between July 1, 1930, and June 30, 1931, the range in water level was from 13.3 feet down to 1.9 feet below zero. Daily readings have been made at St. Louis since January 1, 1861, and in the entire series of records no like period of low stages can be found. It can, therefore, be safely said that less water reached Cairo from the upper Mississippi in the year ended June 30, 1931, than in any other year for which records are available. This can be said despite the fact that low-water readings are not as nearly comparable as high-water stages. Some low stages are caused by severe freezes, and others are due to the fact that the river, unaided by dredges, will cut its way through bars in a protracted period of low stages. (The stages that have prevailed at St. Louis since June 30, 1931, are lower than those of a year ago.)

There was no necessity for the issuance of flood warnings, but the period was valuable for the river forecasters, in as much as it afforded an opportunity for the uninterrupted study of forecasting methods, based on the long series of data that are available at most river-district centers.

Requests for river-stage data have increased considerably, on account of the development of all branches of hydraulic engineering. In the past year especial attention has been given to the accurate recording of low-water stages, as the demand for low-water data is second in importance only to the extremely high stages.

Cage and bench-mark descriptions have not been published since 1928. This information is used constantly by hydraulic engineers, and it is being thoroughly revised by publication in Daily River Stages for 1931.

Weak spots that have appeared in the observational and reporting system have been strengthened where possible by the addition of river-stage and rainfall stations.

In the Colorado Basin work has been continued on an intensive scale to enable the forecasting of the discharge of the lower Colorado, in cubic feet per second. These forecasts have been largely for use in preliminary work in connection with the Hoover Dam, and as construction work progresses they will become still more valuable.

Advantage has been taken of the low water to repair and adjust river gages. The encouraging progress that has been made has been, of course, due in good part to low rivers, but it was in a greater measure made possible by the assignment of two Weather Bureau men to the technical inspection of river gages, and to the repair work shown to be necessary by the inspections. Weather Bureau problems, involving the forecasting of both ordinary stages and flood heights, differ so greatly from other hydrologic problems that it has been found quite necessary to have instrument men trained in Weather Bureau practice, and thoroughly familiar with the public demands that must be met by the bureau, to make the surveys at and around the river-gage stations. More instrument men are needed, but under the existing conditions no effort is being made to obtain them.

Valuable aid has been given the bureau by the Army engineers and engineers of the United States Geological Survey, in the repair and adjustment of gages. In most cases the Weather Bureau has reimbursed the cooperating services, by a transfer of funds, for the work done. In other cases the work has been performed on a purely cooperative basis.

Snowfall measurements in the mountain snow fields of the Western States have been continued. This work is rapidly assum-

ing a character that is more local than the Weather Bureau can properly handle, and efforts are being made to reach an agreement under which the bureau will carry on general observations or measurements that may be considered representative of large regions, while towns, and irrigation or power plants, will make the very intensive surveys in the smaller basins from which they draw their supplies of water.

AEROLOGICAL ACTIVITIES OF THE BUREAU

It is well understood that there has been, since the passage of the air commerce act in 1926, a very active extension of the work of the Weather Bureau in its aids to the navigation of the air, and this topic has been well covered from year to year in the reports as submitted. Notable extensions were made in this program of work during the last fiscal year, and at the same time the urgency for economy has called for special consideration, resulting in very appreciable savings being made from the appropriations. This has been brought about, without impairment of the service, by the elimination of some of the least important features and by the postponement of some part of the program of fixed expenditures, awaiting more urgent need thereof on the part of transport activities. Naturally, the depression has affected the latter activities and lessened the urgency for extensions originally contemplated. This policy of conservatism will characterize the program of work for the ensuing year.

WEATHER BUREAU STANDARD OF ANEMOMETRY

Stations of the Weather Bureau, from their origin, about 1872, to the close of 1927, used only one fixed type of Robinson 4-cup anemometer for all measurements of wind movement and velocity. The cups were of hemispherical form, 4 inches in diameter, mounted on slender steel arms nominally 6.72 inches from the axis of revolution to the centers of the open faces of the cups.

Between the years 1888 and 1890 these anemometers were given a somewhat limited series of calibration tests, first by means of a hand-driven whirler installed in the large closed court of the Pension Building. When this equipment was used at

night, when the air within the great court was exceptionally still, the anemometers could be whirled in a great circular path about 56 feet in diameter. Limited to hand power, however, the test velocities did not exceed about 35 miles per hour.

Subsequently the performances of the anemometers were checked in the high natural wind velocities which occur with frequency on the summit of Mount Weather. To give strength to the results for higher velocities, flat, thin pressure plates normally exposed to the wind stream were also tested for pressure coefficient per unit area.

The results of both lines of tests have been completely sustained by the wide extension of aerodynamic knowledge made possible by the advent of aeronautics and the development of wind-tunnel test laboratories of the highest order.

Briefly presented, the results of the investigation ending in 1890 are as follows:

Under ordinary open air conditions, relatively thin flat plates, ranging from 1 to 3 feet square, exposed normally to the wind will experience a total wind pressure, in pounds per square foot, given by the equation

$$P = 0.004 \frac{B}{30} W^2 \quad (1)$$

In this equation B represents the average barometric pressure. The ratio $\frac{B}{30}$ is needed in case wind-pressure values are desired at localities which are some distance above sea level. The wind velocity represented by the term W must be the true or corrected velocity if derived from indications of the cup anemometer. The tests led to the conclusion that this true velocity could be obtained from the standard 4-cup anemometer by the following equation:

$$\log W = 0.509 + 0.9012 \log v \quad (2)$$

in which v is the linear velocity of the centers of the cups, that is, the indicated velocity $V \div 3$.

The pressure formula (1) is believed to still quite correctly represent wind-pressure conditions on engineering structures in the open air, and it has also been found that the table of true wind velocities by equation (2) as published in 1890 when extended far beyond the highest test velocities to indicated velocities of 120 miles per hour, gives what the latest tests show are true wind velocities within a variation which attains a maximum difference of less than 2 miles per hour at 120 miles per hour indicated velocity.

These very satisfactory interpretations of the performance of the Robinson 4-cup Weather Bureau standard anemometer were attained by the present chief of the bureau in his former position in charge of the Instrument Division.

While it was quite unknown how really reliable at high velocities were the tests made in 1890, arrangements were made in 1922 with the director of the Bureau of Standards to carry out, in the wind tunnels of the bureau, new tests of various cup anemometers at the highest attainable velocities. This new undertaking was entrusted to Sterling P. Fergusson, of the Instrument Division of the Weather Bureau, assisted by his associate, Foy N. Covert. Officials in charge of the wind tunnels at the Bureau of Standards cooperated in the most cordial way to make a thoroughgoing success of the very considerable number of tests carried out, and the body of observational results are believed to be among the very best of this character available up to the present time.

About this time John Patterson, now director of the Canadian Meteorological Office, also undertook, independently, certain tests of the cup anemometer, and was led to the conclusion that the 3-cup wheel presented certain advantages over the 4-cup wheel. On the basis of Mr. Patterson's work, 3-cup wheels were given very extended tests in the Weather Bureau experiments at the Bureau of Standards, with the ultimate result that, beginning January 1, 1928, instructions were issued to all Weather Bureau stations to replace the old standard 4-cup anemometer by new instruments of the 3-cup type. The essential features of this action have been published in the Monthly Weather Review for April, 1924.

In order to meet the needs of aeronautics, particularly with reference to the phenomenon of gustiness of the wind velocities and its effect upon the problem of airship manoeuvring and operation, the chief of the bureau himself undertook certain investigations, by means of very light magneto types of anemometers, and in the course of these certain questions arose leading him to an entirely new analysis of the original observational data obtained in the tests at the Bureau of Standards. This work has been carried out with unusual thoroughness, because it developed that some of the claims for superiority of performance of 3-cup anemometers were by no means borne out by his rigid method of analysis. Moreover, all parties engaged in these studies are in perfect agreement concerning the performance of 4-cup anemometers, about which decidedly the largest body of test information is available. In contrast to this, the wind velocities of the 3-cup anemometers, as shown by at least one or more station records, are in conflict with corresponding records previously made by the 4-cup anemometer.

These circumstances, taken in connection with the fact that the test of the performance of the 3-cup anemometer has been represented thus far only by certain graphic diagrams, and is not on any very definite, tangible basis corresponding to the definite equation like No. 2, established in 1890, it has been decided to be most proper for the bureau to return to the 4-cup standard, on or before January 1, 1932, if practicable. This will bring about the greatest homogeneity in wind movement velocity records of the bureau from its earliest days to the present time. The records accumulated during the interim between 1928 and 1932, while the 3-cup anemometer was used as the standard, will be coordinated in some proper way with the old and new records from the 4-cup instruments.

In order to make this brief report of the researches upon anemometry fairly complete, it is necessary to present the principal mathematical equations which suffice to completely represent the performance of any Robinson anemometer having cups from 4 inches, or somewhat less, in diameter to 5 inches or slightly over, on arms ranging from 3 or 4 inches long to 10 or 15 inches in length.

For such anemometers it is found that if L = length of arm then

$$\underline{b} = \frac{5247.8 - 17.78 L}{L + 0.7976} \quad (3)$$

In this equation \underline{b} is a number which expresses the maximum or limiting number of turns which the cup wheels tend to make per mile of wind travel as the wind attains higher and higher velocities. At low and moderate velocities our investigation shows that cup wheels of all kinds make a relatively small and moderate number of turns per unit wind travel. For each cup wheel this number increases, rapidly at first, thereafter more and more slowly, and approaches asymptotically to the value \underline{b} as hurricane wind velocities are attained. This quantity \underline{b} is a fundamental characteristic of the performance of each cup wheel, and as equation (3) above indicates it is dependent quite wholly upon the length of the cup wheel arms.

It is quite certain there are minor secondary effects upon the value of \underline{b} , due to the size and number of cups (doubtless limited to 3 or 4) frictional restraints active at high velocities, as well as structural features of the cup wheels. While the whole body of tests made at the Bureau of Standards were quite diverse and generally self-consistent, nevertheless it was quite impossible to definitely segregate and evaluate the minor secondary effects mentioned from irregular accidental variations, and it is gratifying to find that this important limiting value of the constant \underline{b} for all cup-wheel anemometers such as used at meteorological stations can be computed in any case by equation (3).

As we have mentioned, the actual number of cup-wheel turns per unit of wind travel depends upon the velocity itself. Let this number be represented by \underline{N} and the true velocity \underline{W} , hence the product

$$\underline{NW} = \text{cup-wheel turns per hour.}$$

Now in all practical uses of cup-wheel anemometers a certain arbitrary number, like 500, is chosen in the old standard anemometer, or 640 in the 3-cup instrument, as the assumed constant num-

ber of cup-wheel turns per mile of wind travel. These numbers are incorporated in the fixed gear trains of the instruments, and in practically all station anemometers, so-called mile marks are electrically registered, thus giving what is called the indicated velocity V . Calling the arbitrary chosen number A we have another product -

AV = cup-wheel-turns per hour.

Finally, the basic equation of all anemometry becomes

$$NW = AV \quad (4)$$

and our whole investigation gives us for any anemometer

$$V = \frac{bW(W - W_0)}{A(W + a)} \quad (5)$$

In this equation W_0 is a small friction constant for low velocity effects, and represents the velocity of wind which is just adequate to keep the cup wheels in very slow motion. We have found it best to assign a fixed value to this constant of from 0.5 to 1.5, according to whether the axis turns very freely, as in ordinary instruments, or with some resistance as in the magneto anemometers. The constant a is also a small one like W_0 . Both are nearly the same for all anemometers tested, and the value of a ranges from about 2.0 to 3.0 for instruments like the 3 and 4-cup standards.

The findings show that under like conditions of friction, size, construction and choice of gear train, as represented by A , 3-cup and 4-cup anemometers perform practically alike.

Supplying the final numerical values to equation (5) we get the working equation for the old 4-cup standard, as follows:

$$V = \frac{681.1 W (W - 0.67)}{500 (W + 3.04)} \quad (6)$$

This equation will be found to give almost the same values of W and V as equation (2) within the velocity range of V between 10 and 120 miles per hour, but (6) may be safely extended to indicated velocities as high as 200 miles per hour, and values will check out closely with the highest observed tests at nearly 140 true, or 184 miles per hour indicated velocities.

More complete details of this subject will be published in the Monthly Weather Review.

